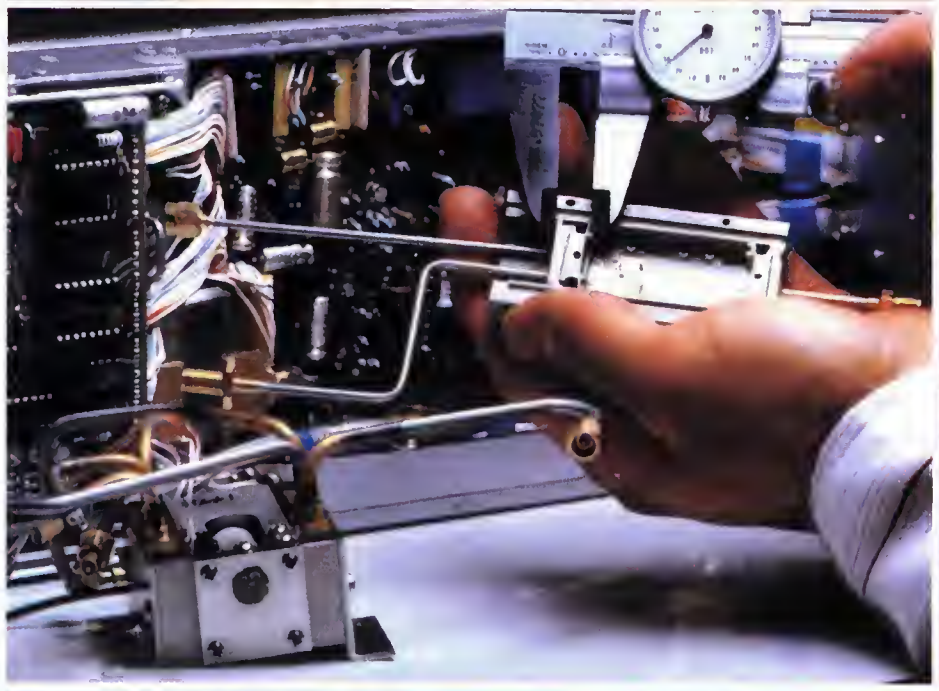
Tektronix 1981

Pioneering is our heritage. Customer satisfaction is our measure of success.

Thirty-three years ago, Tektronix was six people and one major product: the best oscilloscope in the world. To this day there's still no close second to Tektronix in cathode-ray oscilloscopes. As a worldwide company of over 23,000 people with $1 billion in sales, we're not only a leader in oscilloscopes, but in many other kinds of test and measurement devices. In computer graphics. In television operational equipment. In microcomputer development products and more. For over 50,000 customers.

We've made it our business to create products and services that deliver unmatched value to you and your organization . . . that provide the greatest return for your investment.



There's no guesswork to our quality. When we tell you a product will meet certain standards of performance, it will. We know that means more ingenuity. More time and effort. Even more improvements at the component level.

You can be sure your Tektronix instrument will do what we say it will do. Our product specifications are tight and accurate: if a product fails to perform to published specifications during the warranty period, we correct it or replace it.

Precision instruments needn't be delicate. We torture our equipment under worse conditions than it will probably ever encounter. It's no accident that reliability has become a byword for Tektronix.

We torture products until they fail. Then we find out why. When they fail in the field, we find out why, too. We use this feedback from the real world to build better products, the kind you can depend on when it really counts.

Tektronix 1981

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Compact, reliable physiological monitors. Portable and versatile for bedside, transport, intensive care, operating room or nursery. Options include hard copy and multiple digital readout.

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Our Newest Products

The Tektronix 8550 Microcomputer Development Lab is a versatile software development and hardware/software integration system for microcomputer-based product design. The system supports many 8- and 16-bit microprocessors, allowing the user to configure the 8550 for a wide variety of design types. See page 20.

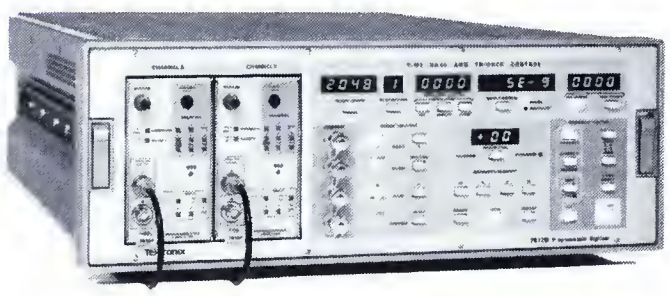
The 7854 Oscilloscope represents a new approach to waveform measurements. It displays solutions to common measurement problems on screen at the touch of a button. Now you can concentrate on decision making instead of measurement taking. The 7854 gives you the features of a TEK 7000 Series high performance scope linked with digital storage (400 MHz bandwidth) and waveform processing. It also provides programmable measurement routines, GPIB interface, and compatibility with 7000 Series Plug-ins. See page 104.

The 7B87 is a horizontal time base designed for use with the 7854 Mainframe to provide additional pre-trigger capability. It may be used with the 7700, 7800 and 7900 Series Mainframe as a delaying time base. The pre-trigger feature is only compatible with the 7854 at this time. See page 117.

The 5223 Digitizing Plug-in Oscilloscope provides storage of repetitive signals up to 10 MHz and has a 1 MHz sample frequency which gives approximately 100 kHz single shot bandwidth. The real time display adds all the features of a conventional scope with a high resolution CRT. Other features include (using the new 5B25N Time Base) simultaneous sampling of left and right compartments, pretrigger, simultaneous display of X vs Y and Y vs Time, ROLL mode, chart recorder output and optional GPIB interface. See page 136.

The new Tektronix 7D02 Logic Analyzer is a 3-wide plug-in for the well known 7000 Series Oscilloscopes; second in a family of plug-in logic analyzers which expand the 7000 Series into logic analyzer applications.

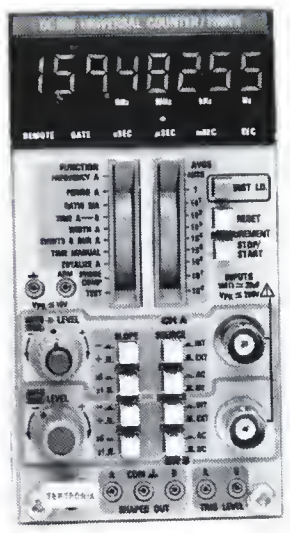
The 7D02's versatile triggering and qualification allow a designer to track very complex programs or data patterns in a very simple programming structure. Keyboard layout and menu correspond to high level programming languages commonly used in microprocessor development (Pascal, PLM). See page 31.

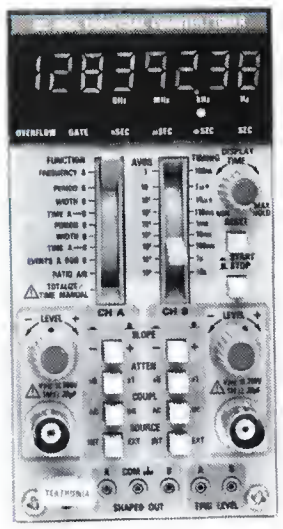


The 7612D Programmable Digitizer can capture single shot or repetitive signals from submicroseconds to seconds in duration. With its 200 MHz maximum sample frequency, you can simultaneously digitize two channels or digitize both channels with independent instrument settings. Up to thirteen different digitizing rates may be linked into a single waveform record. The 7612D is fully programmable via GPIB when used with the 7A16P vertical amplifier. See page 106.

The 468 Digital Storage Oscilloscope features 10 MHz single shot storage ability plus all the 100 MHz performance of the 465B. Stored waveforms can be expanded or repositioned, and cursors provide accurate voltage and time measurements. A unique mode, ENVELOPE, gives glitch-catching, aliasing detection, and baby-sitting capabilities.

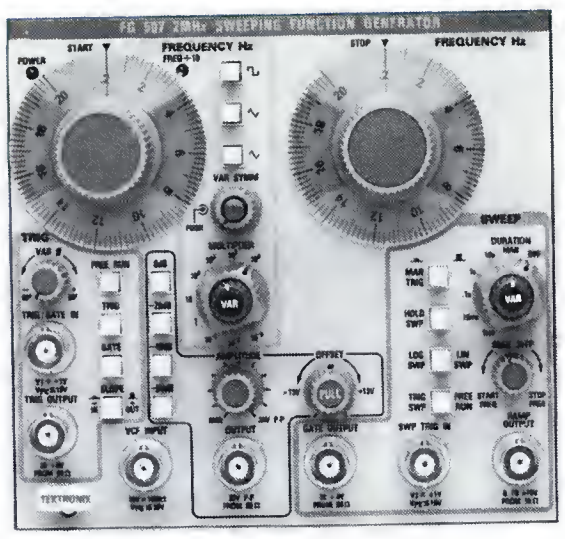
Optional features include signal averaging, IEEE-488 output, and a TV sync separator. See page 166.



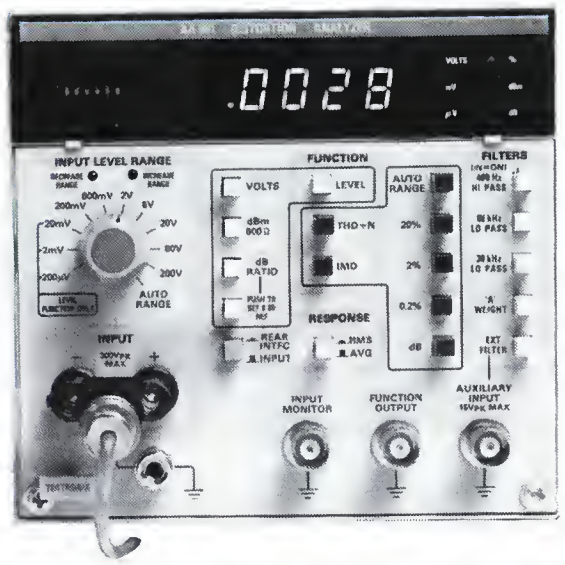


The 135 MHz DC 509 Universal Counter/Timer makes frequency and period measurements using the powerful reciprocal counting technique. This method provides high resolution of low frequency signals much faster than conventional counting techniques. The DC 509 features eight measurement functions, auto trigger mode auto-averaging, probe compensation and 10 ns single-shot resolution in all timing modes. See page 190.

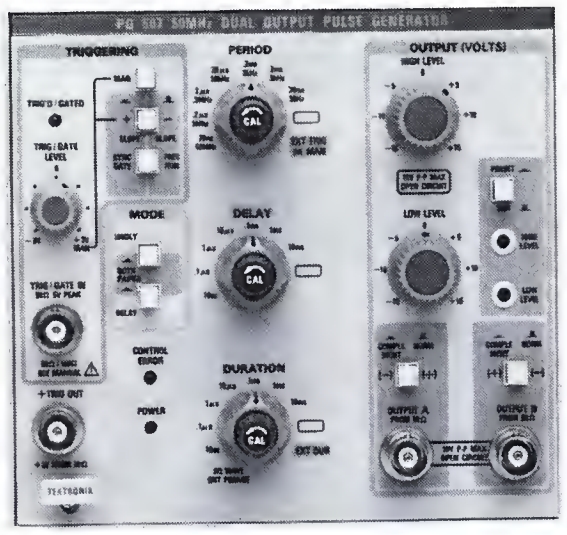
The DC 503A Universal Counter/Timer offers a broad range of measurement features at an affordable price. The 125 MHz DC 503A has two identical input channels with separate trigger level, trigger slope, coupling, and attenuation controls. The DC 503A also features averaging, trigger level and shaped signal outputs, 100 ns single-shot resolution, and 10 ps time interval averaging resolution. See page 192.



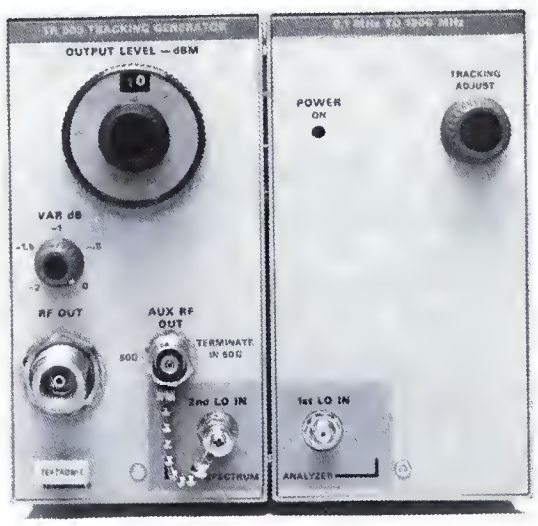
The FG 507 adds the high performance capability of logarithmic and linear sweep to the capabilities of the new FG 501A. The FG 507 sweep capability features separate start/stop frequency dials, sweep up or down, sweep and hold triggered sweep and manual sweep. This combination of features makes the FG 507 one of the most versatile and easy-to-use function generators available for audio or telecommunications applications. See page 202.



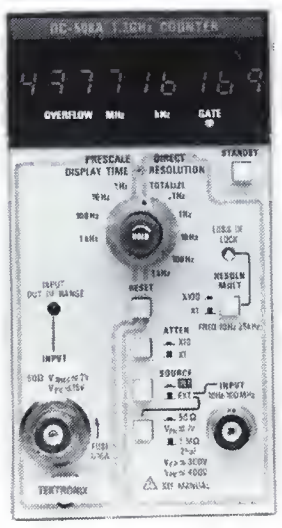
The AA 501 Distortion Analyzer makes complex distortion measurements easier than ever with no compromise in performance. The AA 501 is totally automatic and measures total harmonic distortion, gain/loss, signal-to-noise ratio, and audio levels. Total system residual distortion plus noise (THD+N) will not exceed .0025% when the AA 501 is used with the SG 505 Oscillator. See page 206.

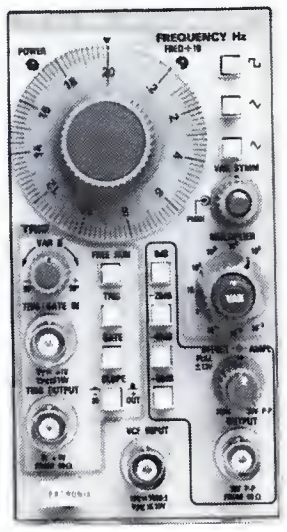


The PG 507 is a high performance, 50 MHz pulse generator designed for logic design applications. The PG 507 features dual outputs, with tracking level controls, normal or complement pulse output on both channels, 15 V output in a ±15 V window into high impedance, 7.5 V into 50 Ω, and 3.5 ns rise/fall time. See page 198.



The TR 503 works with the 492/492P Spectrum Analyzer to provide constant level, calibrated rf sources for swept frequency tests to 1800 MHz. See page 249.





The DC 508A 1.3 GHz Frequency Counter extends the TM 500 frequency measurement capability through the communication bands including frequencies used in testing navigational aids. The DC 508A features nine-digit accuracy, and a X100 frequency multiplier to increase resolution. See page 192.

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms — sine, square, triangle, ramp and pulse— at output levels up to 30 V peak-to-peak and up to ±13 V of offset from 50 Ω source. The FG 501A is a versatile function generator designed for many signal source applications. See page 203.

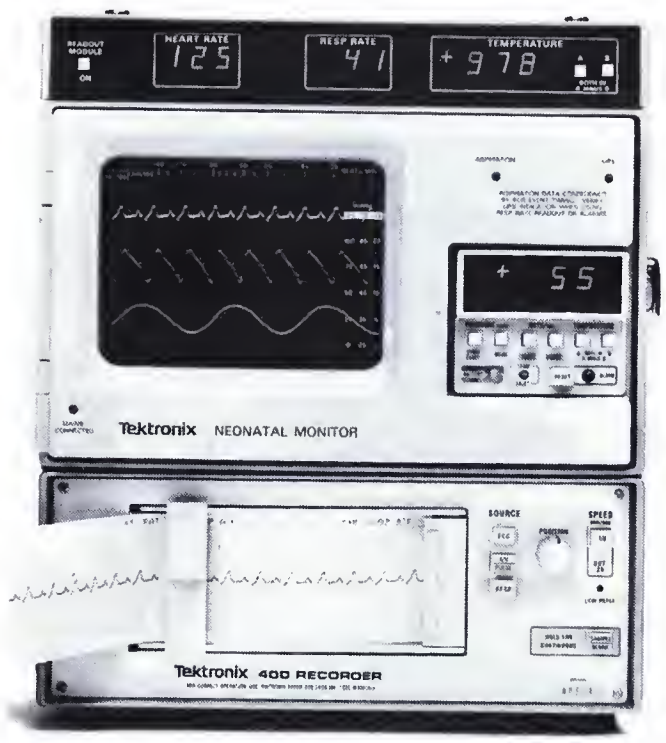
The CG 551AP is a micro-processor based oscilloscope calibration generator that is fully programmable. It can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters including vertical gain, horizontal timing and gain, vertical bandwidth/pulse characteristics, probe accuracy and compensation, current probe accuracy, and calibrator output accuracy. See page 209.

The 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. The 492P is easy to use and easy to program with its high level language. It provides automatic set up and its internal processing reduces processing time and saves software development. For example, you get automatic signal tracking, auto peaking, automatic identification of signal peaks above a specified amplitude. See page 240.

Our Newest Products

The new Tektronix 834 Programmable Data Comm Tester is designed for use by first-line field service technicians: a powerful, portable, go/no-go tester which quickly "points a finger" at the faulty element in a down data communications network. See page 178.

The 834 isolates the problem by monitoring the data link. Field service technicians can simulate the data terminal equipment (DTE) or data communications equipment (DCE) to verify the performance of components of the entire data communications channel.



The Tektronix 413A Neonatal Monitor is a three-trace instrument that simultaneously displays ECG, blood pressure or peripheral pulse, and respiration waveforms. A selectable digital readout shows heart rate, respiration rate, systolic/diastolic or mean blood pressure, two temperatures, or temperature difference. See page 254 for more information.

The P6202A replaces the P6202 and offers the same package and performance except that the P6202A deletes the power supply furnished with the P6202. A standard "Limo" connector allows the P6202A to draw power from the probe power receptacle on TEK Scopes. See page 273.

The A6902 Isolator permits floating measurements over two independent signal paths to ±1500 VDC measured to "green" ground. The A6902 contains two switchable attenuators and permits the oscilloscope or other measuring device to remain grounded and safe. The A6902 achieves a bandwidth of up to 15 MHz derated for signal voltage. See page 287.

The A6901 Ground Isolation Monitor permits floating measurements by interrupting the "green" ground path. Green ground to the device plugged into the A6901 is re-established within 200 milliseconds if there is more than 30 VRMS present on the floating device's chassis. See page 286.

An NTSC test signal generator and VITS inserter, featuring 10 bit digital signal generation, new test signals, digital word input and output, and RS-232-C and ground closure remote control interfaces.

The 1900 Digital Test Signal Generator and VITS Inserter is designed for state-of-the-art performance testing of NTSC video systems and equipment. Available in three different versions, this generator supports a wide range of transmitter, studio, common carrier, and equipment manufacturing applications. The three 1900 versions available are the Transmitter Test Set, the Studio Test Set, and the NTC 7 Test Set. Each version provides a special test signal complement. See page 257. For more complete information, request the Television Products Catalog using the return card at the back of this catalog.

USING THIS REFERENCE SECTION

The products in this catalog cover a range of capabilities in a number of areas. In many cases you'll have several products from which to choose. These introductory notes are intended to help you review some of the factors involved in making a selection.

This reference section can only outline some of the major factors involved. If you need more information, contact your local Tektronix Sales Office, Representative, or Distributor — we're ready and eager to help.

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A discussion of the IEEE 488 standard for instrument interface, the advantages of interface, and the benefits of the *Codes and Formats* standard incorporated in each Tektronix GPIB product. Systems are described, as well as individual waveform measurement instruments, graphic controllers, and peripherals.

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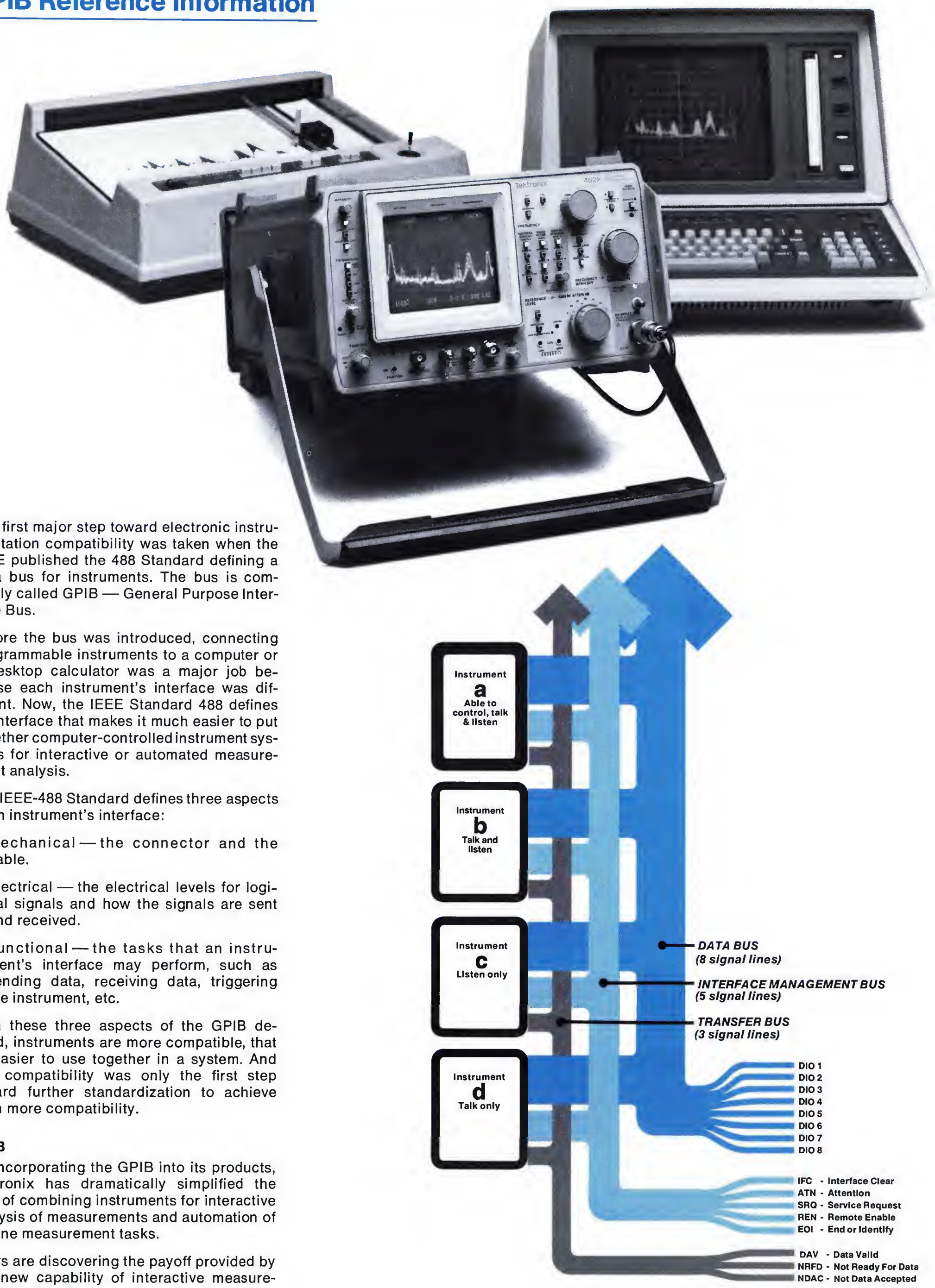


The first major step toward electronic instrumentation compatibility was taken when the IEEE published the 488 Standard defining a data bus for instruments. The bus is commonly called GPIB — General Purpose Interface Bus.

Before the bus was introduced, connecting programmable instruments to a computer or a desktop calculator was a major job because each instrument's interface was different. Now, the IEEE Standard 488 defines an interface that makes it much easier to put together computer-controlled instrument systems for interactive or automated measurement analysis.

The IEEE-488 Standard defines three aspects of an instrument's interface:

1. Mechanical — the connector and the cable.
2. Electrical — the electrical levels for logical signals and how the signals are sent and received.
3. Functional — the tasks that an instrument's interface may perform, such as sending data, receiving data, triggering the instrument, etc.

With these three aspects of the GPIB defined, instruments are more compatible, that is, easier to use together in a system. And 488 compatibility was only the first step toward further standardization to achieve even more compatibility.

GPIB

By incorporating the GPIB into its products, Tektronix has dramatically simplified the task of combining instruments for interactive analysis of measurements and automation of routine measurement tasks.

Users are discovering the payoff provided by this new capability of interactive measure-

ment analysis. The ability to connect a computer like the 4052 Desktop Computer System, via the GPIB, to a measurement instrument such as a 492P Spectrum Analyzer, makes it possible to capture a waveform and then transfer it to the 4052 where it can be displayed at various levels of detail. Instrument settings can be changed from the 4052 and new measurements made for comparison and analysis.

Other GPIB instrument users are discovering the benefits of

— improved repeatability of instrumentation set-up

— automation of repetitive measurements

— compilation and statistical analysis of measurements

— automatic calibration

— hard-copy print-out of measurements and analysis.

Prior to the incorporation of GPIB interfaces into controllers and instruments, users desiring the benefits of connecting instruments to computing devices had to invest considerable time and money into the development of custom interfaces. Now, using the GPIB interfaces, the hardware interfacing becomes a simple matter of plugging the instruments together.

Standardized *CODES AND FORMATS* make programming of Tektronix GPIB instruments easy.

Not only are Tektronix GPIB instruments designed to meet the specifications for the updated IEEE-488-1978 Standard Digital Interface for Programmable Instrumentation; but English-like software command formats have also been standardized throughout the product line.

Tektronix has adopted a *CODES AND FORMATS* standard intended to provide a common message structure for GPIB instruments, thereby enhancing their ease of use. This standard is both a language syntax and a system control protocol. The language syntax describes the types of communications elements, and the rules by which these elements can be put together to transmit meaningful messages. The system control protocol standardizes features important to test and measurement systems.

The benefits of this approach are numerous. *CODES AND FORMATS* are a major feature of the Tektronix GPIB communications protocol. Because of their natural English-like structure, they are easy to use. Our GPIB implementation is specifically designed to overcome the programming rigidity and cumbersome procedures of previous GPIB systems.

Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set

the center frequency at 1.75 MHz in our 492P spectrum analyzer from a controller, the command is simply written "FREQ 1.75 MHz"

In the Tektronix implementation of GPIB, measurement data are not only *coded* in familiar ways, but they are also communicated over the bus in the same *format* — *CODES AND FORMATS*.

Built-In Intelligence allows users to devote their full attention to waveform analysis and processing

Tektronix GPIB instruments do not have the machine-like rigidity of many automated products. They are designed for human interaction. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper and lower case letters. And since truncated numbers can drastically affect measurements, Tektronix instruments round off rather than truncate, e.g., a value of 2.49 becomes 2.5 rather than 2.4.

In addition, Tektronix GPIB controllers automatically perform most communications coordination and system management functions. Users can ignore the workings of the interface and devote their full attention to waveform analysis and processing.

Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE-488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users won't generally need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit.

These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

GPIB System Components

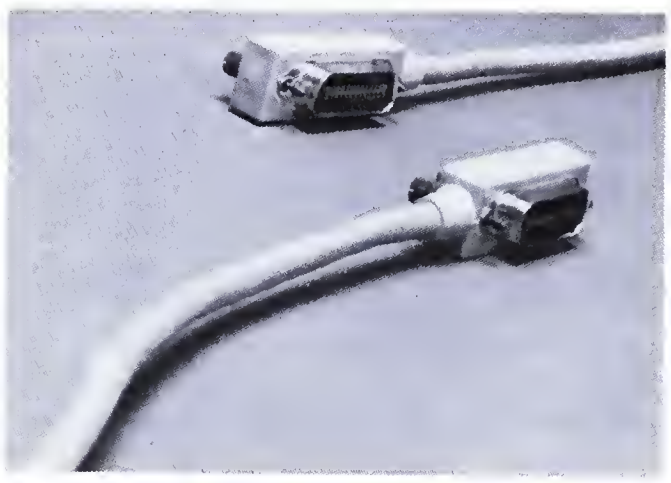
An automated test and measurement system usually consists of the following components:

- A number of instruments: These are either *stimulus* instruments, such as frequency generators, pulse generators, and power supplies, or *measurement* instruments, such as counters, waveform digitizers, and multimeters.
- A controller: It tells the instruments what to do, collects the results, and processes them. This system controller is generally a small computer.
- Computer peripherals: These are devices such as tape drives, printers, and plotters that store or display the results of the tests.
- A keyboard: This enables the user to send commands or information to the system.
- A display: The display allows the user to review intermediate results and to monitor system operation.

GPIB Reference Information

The last three components are often incorporated in the system controller — a desktop computer that is specifically designed for use with instrument systems.

All these components can be easily interconnected if the standard GPIB interface has been built into them and appropriate functions made programmable. Before the GPIB existed, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. With the GPIB this is no longer a requirement. Users can directly link up to 14 instruments with the bus, which connects to the controller, and set up the systems in linear or star formations. Figure 1 shows these two typical system configurations. Each GPIB instrument or peripheral, called a device, must be assigned a system address. The user assigns each device its address simply by setting switches, usually located on the back panel of the device.



Standard cables are used to connect all the devices.

All these devices — the controller, measurement instruments, and peripherals — comprise the hardware. The system cannot operate, however, unless it is driven by software, the other part of an automated system. The users of the system must usually generate the specific application software for their systems. The software works through the controller to tell the instruments what signals to generate and what measurements to make, and it tells the controller what to do with the results.

The software and the program in the controller make the system do what the users want. The GPIB interface allows users to plug system components together, but without software the system can do nothing.

In programmable instrument systems, the "language" of the software or program has several meanings:

1) The controller has its own language, such as BASIC, and users must express their intentions in this language.
2) Within the context of the controller's language, the instrument's commands (or "language") have to be sent over the GPIB.
3) The actual control of the GPIB interface is transparent to the user with a Tektronix 4050 Series Computer as the controller.

Instrument controllers such as the Tektronix 4052 have built-in capabilities that simplify the job of instrument system programming.

In order to make the system operate, the user has to:

1) Know what tasks the system is to perform. The system can do nothing by itself.
2) Know the computer's language.
3) Know the kind of data or language the instruments are designed to receive.

But the 4050 series user does not have to know very much about the operation of the GPIB since the controller automatically handles GPIB operations.

CODES AND FORMATS Assure Successful System Operation

To increase compatibility among devices on the GPIB, Tektronix uses a *CODES AND FORMATS* standard. This standard defines how data are to be sent and received over the GPIB, e.g. it defines a standard message terminator. *CODES AND FORMATS* also explains some other conventions that are not clearly stated in the IEEE-488 standard.

The Tektronix *CODES AND FORMATS* standard goes beyond conventional practice to stipulate how programmable instruments are to be compatible not only with controllers but also with people. Compatibility with system users is called "friendliness".

This means that the instrument command set is designed to be easy for the user — no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human-readable form. Plus, minor format items such as leading zeros, negative zero values are accepted, again making it easier for the user.

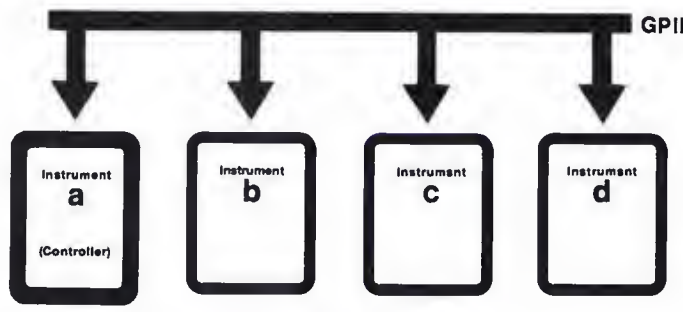
Because users are increasingly interacting with systems at the keyboard rather than at the front or rear panels of instruments, systems must be as friendly as possible. This means, too, that the controller languages should be simple, logical, and easy to interpret or implement. Tektronix controllers, measurements instruments, and peripherals have been designed to meet these criteria as well as the normal technical specifications.

Details of GPIB Operation

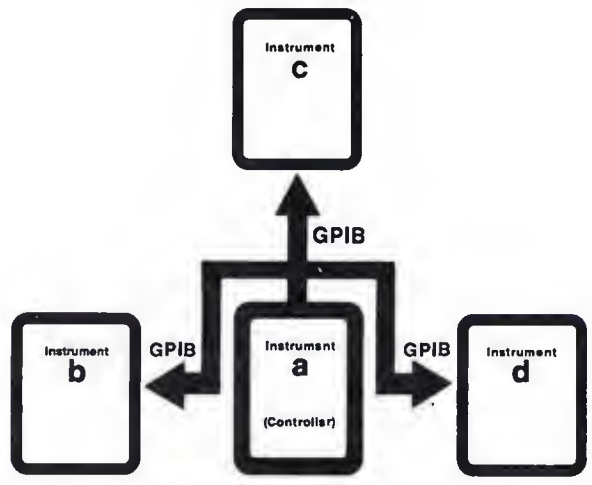
For further information on GPIB and *CODES AND FORMATS,* ask your sales engineer.

Interface Functions Defined by IEEE-488-1978

Function	Description
Talker (T)	allows instrument to send data
Listener (L)	allows instrument to receive data
Source Handshake (SH)	synchronizes message transmission
Acceptor Handshake (AH)	synchronizes message reception
Remote-Local (RL)	allows instrument to select between GPIB interface and front-panel programming
Device Clear (DC)	puts instrument in initial state
Device Trigger (DT)	starts some basic operation of instrument
Parallel Poll (PP)	allows up to eight instruments simultaneously to return a status bit to the controller
Controller (C)	Sends device addresses and other interface messages



Linear Configuration



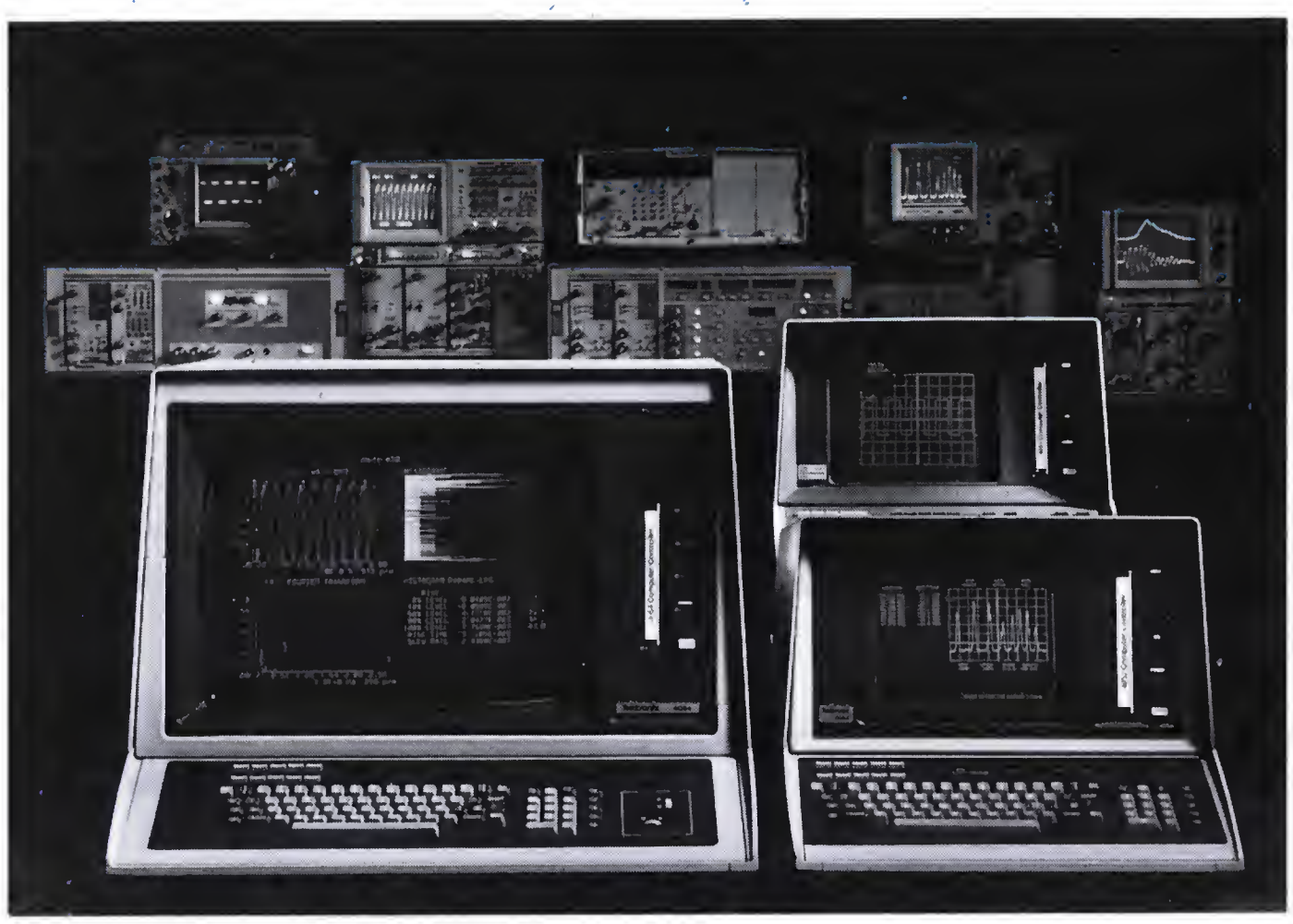
Star Configuration

GPIB Hardware Characteristics

- Cable length of up to 20 meters (approximately 66 feet) with a device load for every 2 meters of cable.

  i.e., cable length $\leq$2X number of instruments

- Up to 15 devices (1 controller and 14 instruments) may be connected in linear or star configurations
- Voltages are generally TTL-compatible
- GPIB signal and data lines are asserted (or true) when pulled low (+0.8 V) and released (or false) when pulled high (+2.0 V). For instance, ATN indicates the ATN line is asserted; ATN that it is unasserted.
- Maximum data rate of up to 250 kilobytes/second over a distance of 20 meters with 2 meters per device, or 1 megabyte/second over a distance of 15 meters, tuned up. Refer to IEEE Std 488-1978 for details.



Tektronix Desktop Computer Systems extend measurement analysis with easy-to-use intelligncе.

Versatile analysis tools make advanced graphic analysis and processing more widely available.

The Tektronix 4050 Series Desktop Computer Systems, used as controllers, make it easy to support GPIB-compatible instruments. Their typewriter keyboards, built-in calculator keypads, and special programmable keys provide easy operation. In addition, the GPIB interface provides for system expansion: as a result users can simply plug in up to 14 devices on a 4050 Series Controller at one time.

All Tektronix Desktop Computer Systems have our exclusive high-resolution storage display for unexcelled graphic clarity and detail. There is no distracting screen flutter. All lines are continuous, never distracting from or distorting information.

The built-in graphics capability allows interactive graphic manipulation to help visually analyze waveform data before they are processed. A user can often gain valuable insights or decide to investigate a new direction once the acquired data are graphically displayed.

Supporting our advanced, interactive graphics capability is powerful computer performance. Features such as full array processing, an invaluable tool for handling whole waveforms, and dynamic memory allocation, both reduce the worry about data movement in the system.

Additionally, a range of peripheral products are available with Tektronix Desktop Computer Systems to provide analysis records in many sizes and formats. Tektronix' high-quality peripheral products include hard copy units, digital plotter, graphic input tablets and disc memory systems.

Software provides new test and measurement capabilities.

With the 4050 Series Desktop Computer, users immediately start using a high-level extended BASIC. This universal technical language is well adapted to the needs of technical users, and includes extensions for increased computational power and further ease of use.

Tektronix also supplies general utility software programs for various communication routines, such as bi-directional transferring of waveform data, test, and numbers. Acquired data can be quickly positioned on the display screen of a powerful Tektronix Desktop Computer System for immediate analysis and manipulation.

Graphic waveform handling is enhanced by built-in features such as auto-scaling, where unknown quantities of waveform data can be scaled into a defined set of graphic coordinates by a few key-stroke operations.

Hard copy plotting from the controller is equally fast and easy. Coordinates may be defined for Log-Lin, Log-Log, or even Smith Chart and Bode plots — whichever is relevant to your application.

Special firmware modules offer advanced processing.

Some of the more common processing tasks can be accomplished using firmware supplied by Tektronix. Plug-in ROM Packs for the controllers provide specialized waveform processing commands. For example, our Signal Processing ROM Pack (#2) uses versatile English-like commands to handle data arrays or whole waveforms.

Other ROM Pack capabilities include fast and inverse Fourier operations to make harmonic analysis of waveform data. The Fast Fourier can transfer whole waveforms from time domains to frequency domains in a matter of seconds; they are always under the user's direct control.

Still other ROM Packs offer advanced graphic handling features, data conversion packages, and other computational tools.

Guide for Selecting GPIB Instruments

When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitability in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your sales engineer when considering instruments to be used in GPIB configurations:

1) Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level, e.g., AH1 is needed for any useful interaction. SH1 is required for instruments supplying measurements to the controller.
2) Is the instrument intended for interactive measurement analysis or automated measurement, i.e. are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?
3) Are diagnostic routines available to check out the instrument over the GPIB interface?
4) Does the instrument respond to universal commands such as "device clear"?
5) Does the instrument use standard codes and formats conventions, i.e., terminators, numeric formats, etc.?
6) Can the instrument's front panel set-up be read from the controller, and saved for later set-up?
7) Can the front panel be "locked out" via the GPIB?

All products in this catalog that incorporate the IEEE-488-1978 standard are identified by the color notation GPIB Product or GPIB Peripheral.

GPIB Reference Information

WAVEFORM GRAPHICS

Tektronix offers state-of-the-art capability in GPIB Waveform graphics products, enabling the user to measure, digitize, process, compare and analyze complete waveforms rather than being restricted to single points or averaging techniques. Following are GPIB products providing this capability:

GPIB WAVEFORM PRODUCTS

			See page
GPIB Waveform Measurement Instruments			
468 Option 02	Digital Storage Oscilloscope	A new portable 10 MHz oscilloscope with the accuracy and convenience of digital storage. Designed for interactive applications.	166
492P	Programmable Spectrum Analyzer	50 kHz to 220 GHz, full programmability, GPIB interface capability, waveform transfer, internal processing. Designed for interactive and automated applications.	240
*7912AD	Programmable Digitizer	Digitizes waveforms as high as 1 GHz to as low as 10 kHz, and stores data indefinitely in 4096 word memory. Designed for interactive and automated applications.	108
*7612D	Programmable Digitizer	2-channel, 8 bit, 200 MHz sample rate with selectable record length and variable sample rates within records. Designed for interactive and automated applications.	106
5223 Option 10	Digitizing 10 MHz Oscilloscope	Capture and store single-shot data up to 100 kHz, unattended. Expand or reposition stored data. Simultaneously display stored and real-time signals. Designed for interactive applications.	136
*7854	Digital Storage and Waveform Processing Oscilloscope	400 MHz Plug-In Oscilloscope with optional memory, programmable measurement routines, high performance. Designed for interactive applications.	104
GPIB Graphic Controllers			
4051	Desktop Computer System	Powerful, easy-to-use desktop computing with graphics and extended BASIC.	52
*4052	Desktop Computer System	High performance, personally manageable desktop computing with graphics and extended BASIC.	52
4054	Desktop Computer System	19 inch screen desktop computing system with enhanced graphics and powerful BASIC.	53
GPIB Peripherals			
4662	Interactive Digital Plotter	Compatible in all RS-232-C ASCII and GPIB environments; and with PLOT 10 and PLOT 50 Graphic Software.	56
4663	Digital Plotter Interactive	C size. 420 mm x 594 mm (17 in x 22 in)	57
4924	Digital Cartridge Tape Drive	Compatible with 4050 Series Desktop Computer System.	61
4907	File Manager	Low cost mass storage, compatible with 4050 Series Desktop Computer Systems.	60

*See pages 71-74 for Tektronix configured systems using these products.

CONFIGURATION

TWO BASIC APPROACHES

There are two basic configurations for test and measurement instruments. Modular instruments, more often called plug-in or laboratory models when referring to oscilloscopes, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments, such as monolithic oscilloscopes, are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all monolithic instruments meet all the objectives of portability. On the other hand, some modular systems, such as the Tektronix TM 500 Test and Measurement Line, are designed for easy transport right into the field. See the reference section on portability for more details.

Modular Design

Versatility is the primary advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit can be made available in separate plug-ins. You, the user, can then choose the ones that serve you best.

Because a modular instrument is so versatile, it can also make use of advances in instrument design. New plug-ins or mainframes can be added, that within the basic limitations of the other units, add new functions or higher performance.

Modularity also allows plug-ins and mainframes to be shared between various uses. For example, with the TM 500 Line, the same general test and measurement plug-ins used in the lab for design work can be quickly inserted into a portable mainframe and easily carried to a service problem. Alternately, where demand warrants it, the identical model plug-ins can be supplied to both field service and laboratory personnel, assuring the repeatability of measurements and minimizing training time.

Plug-ins can also extend the original instrument range to other functions. Digital multimeters, curve tracers, spectrum analyzers and logic analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscopes.

Oscilloscopes

There are two lines of Tektronix Modular Oscilloscopes to choose from. The Tektronix 5000 Series uses two amplifier plug-ins plus one time base. The Tektronix 7000 Series, which offers higher performance in a number of areas, can accept up to two vertical-channel plug-ins and two time bases or other horizontal units simultaneously. In-depth coverage begins on page 75.

MODULAR NON-STORAGE OSCILLOSCOPES

Model Number	Bandwidth**	Minimum Deflection Factor	Number of Traces	Maximum Sweep Rate	Delayed Sweep	Page	Price†
7104	1 GHz	10 mV/div at BW	up to 4	200 ps/div	X	84	$17,620
7904 R7903	500 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	X	86	7,475 7,095
7844	400 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4 Dual-Beam	1 ns/div	X	88	11,155
7704A Opt 09	250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	90	+500
7704A	200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	90	4,220
7603	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	92	2,555
5440	50 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	5 ns/div	X	138	2,090
5110	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns/div	X	142	1,300
7603N11S	Ruggedized oscilloscope system [meets or exceeds MIL-0-24311 (EC) (AN/USM 281 Specs)]	5 mV/div at BW	up to 2	5 ns/div	X	94	6,515

†Price does not include plug-ins.

**Bandwidths are real time.
Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

Test and Measurement Instruments

The Tektronix TM 500 Test and Measurement Line is a modular system. One-three-four-five-and six-compartment mainframes accept a broad selection of plug-in units. The mainframe unit provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as importantly, TM 500 Mainframes also provide a signal control and data interface between modules. This allows TM 500 units to work either individually or together as integrated measuring systems. The Tektronix TM 500 Test and Measurement Line is extensive: more than 30 units, including power supplies, signal sources, oscilloscopes modules, a logic analyzer, digital multimeters, counter/timers, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can also apply TM 500's capability to unusual applications. In-depth coverage begins on page 185.

Other Modular Devices

Logic Analyzers page 30
Waveform Digitizing Instruments and Systems page 71
Spectrum Analyzers page 239
Curve Tracers page 229

Integrated and Monolithic Devices

Taking the other design approach to instrument design, integrated instruments are optimized for a single range of functions. One-piece instrument design provides reduction in weight, increased ease of use, smaller size, and usually lower power requirements when a definite function is required.

Many oscilloscopes of this type are particularly designed for portable use, with rugged cases, environmental protection, and internal or external battery power. In-depth coverage begins on page 149.

Tektronix also offers many other one-piece products designed to be used alone or as elements of larger systems. Each performs its specialized task economically yet fully because it is designed for a specific type of use:

Graphic Terminals page 45
Data Communication Analyzers page 177
TV Products page 256
OEM Imaging Products page 62

To sum up, modular instruments feature versatility, opportunities for tailor-made selection of functions, and a wide range of measurement capability. Integrated designs are strongest in economy for single functions, ruggedness, and portability.

STORAGE

Tektronix storage instruments continue to display a waveform after the input signal ceases. The period of retention runs from a few seconds to essentially unlimited storage time depending on the type of storage used.

Storage oscilloscopes allow easy, accurate evaluations of slowly changing phenomena that would appear only as slow-moving dots. They are also needed for viewing rapidly changing nonrepetitive waveforms whose images would otherwise flash across the CRT too quickly to be evaluated. Storage can also reduce the time to photograph scope traces by allowing you to "compose" the picture. Unwanted displays can be erased as many times as necessary before the photograph is taken.

Storage is used in other Tektronix products, too. For terminals, CRT storage provides an economical means of retaining graphic and alphanumeric displays without requiring refresh circuitry. Curve tracers with a storage CRT show a wider range of waveforms. And monitors with storage find a wide variety of applications.

TYPES OF STORAGE

Tektronix products use two basic kinds of storage — digital and CRT type.

The fundamental difference between the digital storage scope and CRT storage is the form of storage. Digital scopes store data representing waveforms in a digital memory; CRT storage scopes store waveforms within the CRT, either on a mesh or special phosphor.

DIGITAL STORAGE

Digital storage requires digitizing and reconstruction processes. "Digitizing" consists of "sampling" and "quantizing". Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC) in the digital scope. You determine how often digitizing occurs by the time base. The time base uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. The rate at which this happens is the digitizing rate (or sampling rate). Once the data is in the digital memory, it can be read out and reconstructed for displaying or further waveform processing.

Digital storage is typically very easy to use and gives the user crisp, clear displays. Because the data is stored in memory no fading or blooming will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single shot or low repetition signals, or where further signal processing is desired.

DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

Type	Analog BW	Max Dig Rate	Vert. Res.	Data Words per Waveform	Max No. Stored Waveform	Useful* Storage BW (SS)	Equiv** Stor BW (rep)	Page	Price
468	100 MHz	25 MHz	8 Bit	512 in Alt. 256 in chop	4	10 MHz	—	166	$5,000
5223	10 MHz	1 MHz	10 Bit	1024/plug-in	4	100 kHz	10 MHz	136	4,995
7854	400 MHz	500 kHz Ext Clock	10 Bit	Up to 1024	Up to 40	50 kHz	400 MHz	104	10,500
7912AD	500 MHz	100 GHz	9 Bit	512	1	500 MHz	500 MHz	108	23,800
7612D	90 MHz	200 MHz	8 Bit	Up to 2048	Up to 16	20 MHz	—	106	25,700

*Useful Storage Bandwidth is a measure of the highest frequency sinewave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.

**Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent time digitizing techniques.

BISTABLE

The bistable-phosphor CRT uses a special phosphor with two stable states: written and unwritten.

The storage mode allows waveforms to be stored and displayed a minimum of several hours (in some cases much longer) or until erased by operator.

Bistable storage is an easy kind of storage to use. It is also usually the most inexpensive. Some principal applications include mechanical measurements, signal comparisons, and data recording. Most bistable phosphor CRT's have a split-screen viewing area which allows each half to be used independently for storage displays. The split-screen feature provides many unique advantages. With this system, a reference waveform can be stored on one half of the screen and the other half can be used to store the effect that calibration adjustments or the insertion of filters, etc, have on circuit operation. If desired, this technique can be used where the reference portion operates in the stored mode and the other half of the display, operating in the nonstored mode, monitors an external input.

An example of the usefulness of the split-screen feature is in speech therapy. The normal speech pattern is recorded on the upper half of the storage screen and the patient's attempts to match this pattern are recorded on the lower half. With split-screen operation, the lower half showing the trial waveform can be erased as many times as desired without affecting the stored information on the upper screen.

VARIABLE PERSISTENCE

Variable persistence storage allows a continuous gradation between the bright written level and the dark reference.

The variable persistence mode also allows for the selection of the time a stored image will be retained. The storage persistence can be adjusted so the entire waveform can be viewed, yet the stored trace fades from view just as the new waveform is being plotted. With the save feature, an entire display can be stored for further analysis if desired.

Applications for variable persistence storage include real time, spectrum analysis, time-domain reflectometry, sampling and other measurements which require slow sweep displays. For fast repetitive sweeps, the storage persistence can be set so multiple traces are displayed before the first trace fades from view. Then you can view changes in signal response with changes in circuit conditions, time, or adjustments. This method can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Any aberration or jitter not common to all repetitive traces will not be stored or displayed. Low repetition rate, fast rise time signals that are not discernible on conventional CRT's can be easily viewed.

This type of storage provides the best display when storing displays with varying intensities, such as delayed sweep or with Z-axis intensity modulation. Variable persistence storage provides very good displays for photographs due to the high contrast between dark background and bright waveforms.

FAST TRANSFER

Fast transfer storage uses a tube with a special intermediate mesh target. This target, which is optimized for speed, captures the waveform and then transfers it to a slower, longer-storing electrode. The second target can be designed to offer bistable or variable persistence modes, in combination with the transfer mesh or by itself.

Several Tektronix Oscilloscopes use this combination of capabilities to provide unique multimode storage. By front-panel controls, users of these instruments can select the operating mode suited to the specific measurement situation.

CRT STORAGE OSCILLOSCOPES
(in order of Stored Writing Rate)

Model Number	Stored Writing Speed	View Time	Type of Storage	Band-width**	Minimum Deflection Factor	Number of Traces	Delayed Sweep	Plug-in	Page	Price
7834	5500 div/μs	30 s ††	Fast Variable Persistence	400 MHz	20 mV/div at BW 10 mV/div at 325 MHz	up to 4	X	X	97	$10,395
	776 div/μs	30 min minimum	Fast Bistable							
	12 div/μs	30 s ††	Variable Persistence							
	0.2 div/μs	30 min minimum	Bistable							
466	3000 div/μs	15 s ††	Fast variable persistence	100 MHz	5 mV/div at BW	up to 2	X		168	6,275
	3 div/μs	15 s ††	Variable persistence							
7633	2200 div/μs	30 s ††	Fast variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	99	6,860
	400 div/μs	30 min minimum	Fast bistable							
	3 div/μs	30 s ††	Variable persistence							
	2 div/μs	30 min minimum	Bistable							
7623A	150 div/μs	30 s ††	Fast variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	99	5,250
	50 div/μs	30 min minimum	Fast bistable							
	0.5 div/μs	30 s ††	Variable persistence							
	0.03 div/μs	30 min minimum	Bistable							
464	110 div/μs 0.5 div/μs	15 s †† 15 s ††	Fast variable persistence	100 MHz	5 mV/div at BW	up to 2	X		168	5,115
7613	5 div/μs	1 hr	Variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	101	4,395
5441	5 div/μs	1 hr	Variable persistence	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	139	3,605
434	5 div/μs	4 hrs	Bistable split screen	25 MHz	10 mV/div at BW 1 mV/div	up to 2			165	4,150
5115	0.8 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	142	1,980
5113	0.2 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 dual-beam	X	X	142	2,640
5111	0.02 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	142	1,850
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW 1 mV/div	up to 2			171	1,925
314	0.25 div/μs	4 hrs	Bistable	10 MHz	2 mV/div at BW	up to 2			170	3,170
SC 503†	80 div/ms	4 hrs	Bistable	10 MHz	1 mV/div at BW	up to 2			214	2,850

**Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

†The SC 503 is a TM 500 Oscilloscope that must be plugged into a TM 500 Mainframe for operation.

††View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.

Please turn to page 185 for more information on TM 500 Mainframes.

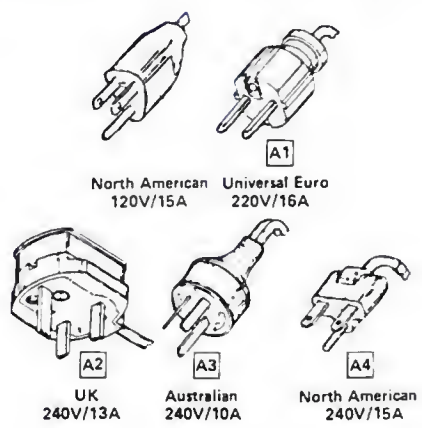
POWER SOURCE CONSIDERATIONS

In general, instruments are factory wired for the nominal voltage of the country of manufacture. Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below if specified on the purchase order.

North American	120V/15A, Standard
Universal Euro	220V/16A, option A1
United Kingdom	240V/13A, option A2
Australian	240V/10A, option A3
North American	240V/15A, option A4



During the life of this catalog the power cord/plug options will be made available on additional instruments. Refer to the individual product ordering information for those products offering these options as of publication date.

Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

Power-cord coding follows one of the two following schemes:

	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow

PORTABLE NON-STORAGE OSCILLOSCOPES

Model Number	Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed SWEEP	Page	Price
485	350 MHz	5 mV/div at BW	X	1 ns/div	X	150	$6,575
475A	250 MHz	5 mV/div at BW	X	1 ns/div	X	152	4,350
475	200 MHz	2 mV/div at BW	X	1 ns/div	X	152	3,910
465B	100 MHz	5 mV/div at BW	X	2 ns/div	X	154	2,895
465M	100 MHz	5 mV/div at BW	X	5 ns/div	X	156	3,150
455	50 MHz	5 mV/div at BW	X	5 ns/div	X	158	2,450
335	35 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div	X	160	2,565
305	5 MHz	5 mV/div at BW	X	0.1 μs/div	X	161	2,020
221	5 MHz	5 mV/div at BW	X	100 ns/div		162	1,495
213	1 MHz	20 mV/div at BW 5 mV/div		400 ns/div		163	1,925
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		164	1,475
T935A	35 MHz	2 mV/div at BW	X	10 ns/div	X	175	1,720
T932A	35 MHz	2 mV/div at BW	X	10 ns/div		175	1,390
T922	15 MHz	2 mV/div at BW	X	20 ns/div		173	1,090
T921	15 MHz	2 mV/div at BW		20 ns/div		173	930
SC 504†	80 MHz	5 mV/div at BW	X	5 ns/div		213	2,650
SC 502†	15 MHz	5 mV/div at BW 1 mV/div	X	20 ns/div		215	1,950

†The SC 502 and SC 504 are TM 500 Oscilloscopes that must be plugged into a TM 500 Mainframe for operation.

Please turn to page 185 for more information on TM 500 Mainframes.

PORTABILITY

Portable Oscilloscopes

For oscilloscopes, a combination of factors must be considered. Small size and light weight are obviously important, but the degree depends on the application and the uses. Similarly, ruggedized cases or dust covers may be required. The Tektronix 200 Series Oscilloscopes, for example, are less than 3 x 6 x 9 in (8 x 14 x 23 cm), weigh less than 3.5 lb (2 kg) and are specifically designed and packaged for field use. The 300 Series all weigh less than 11 lb (5 kg). The high-performance Tektronix 400 Series models, 21 to 26 lb (10.5 to 11.8 kg), are designed as portables, too.

For many applications, internal battery power is often essential. On the other hand, the weight of internal batteries can be a disadvantage if they are rarely needed. In some applications power is always available, since it must be provided to the equipment being tested. Tektronix Portable Oscilloscopes cover the full range of power options. The 200 Series has internal batteries. The 300 Series models and high performance portables, such as the Tektronix 400 Series, are line operated. However, external battery packs are available as accessories for both the 300 Series and the 400 Series.

Our newest portable, the 468, combines digital storage and GPIB capability.

Portable Test and Measurement Instruments

Many of these same factors apply to other instruments besides oscilloscopes. The TM 500 Test and Measurement Line, for example, has several configurations designed for portability. The TM 515 Traveler Mainframe travels like luggage but works like a lab bench set-up. Although it is attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat in most airplanes), the TM 515 is designed to take rugged travel. It carries up to five TM 500 Plug-in instruments. Again, relatively light weight, rugged construction, and convenient size are the key to portability.

Plug-ins include: pulse generators, function generators, other signal generators, amplifiers and filters, oscilloscopes and monitors, lab power supplies, digital counter/timers, digital multimeters, special plug-ins, and custom plug-ins.

All of the more than 30 TM 500 Plug-ins are portable when used with portable TM 500 Mainframes: TM 515 5-compartment Traveler Mainframe, TM 503 3-compartment Mainframe with carrying case or protective cover, TM 504 4-compartment Mainframe with carrying case or protective cover.

In-depth coverage of TM 500 products begins on page 185.

Other Portables

The 492 and 492P Spectrum Analyzers combine lab performance and ease of operation in a compact, lightweight package. Both offer a frequency range of 50 kHz to 21 GHz, extendable to 60 GHz with Tektronix external waveguide mixer, and to 220 GHz with commercially available mixers. The 492P is GPIB programmable via IEEE 488-1978 interface.

Still other Tektronix portable instruments meet special requirements far above simple movability. The 1502 and 1503 TDR Cable Testers, for example, are designed to work outdoors in any weather, including pouring rain.

Tektronix Portable Patient Monitors provide hours of battery-powered operation so they can keep on providing data on vital functions not only during surgery but right through patient transport.

For movement within limited areas, Tektronix SCOPE-MOBILE® Carts and Lab Carts are available in several configurations. A typical setup might include a 400 Series Oscilloscope on the top shelf with two TM 503 Mainframes underneath. These carts are particularly useful for in-plant servicing, school and research laboratories, and similar applications.

Logic Analyzers	page 30
Spectrum Analyzers	page 239
TDR Cable Testers	page 252
Portable Patient Monitors	page 254
SCOPE-MOBILE® Carts	page 293

ENVIRONMENTAL CHARACTERISTICS

The environmental characteristics listed in instrument specifications may include some or all of the following: temperature, altitude, humidity, vibration, shock, and electromagnetic compatibility (emc previously rfi or emi).

The specifications for humidity, vibration, shock, and transportation are intended to be beyond what can be expected in use, and operation at these extremes may cause minor physical deterioration. Such operation, however, should not cause electrical performance to deteriorate outside specifications.

The specifications for temperature and altitude are such that continual use at the limits will not cause significant short-term deterioration. Naturally, higher temperature operation can be expected to reduce longterm reliability and should be avoided if possible. The emc test is completely nondestructive.

Sample production instruments are tested periodically as part of a continual quality-control process. Complete tests on every production instrument are undesirable as well as uneconomical.

For more specific information on the environmental characteristics and how they apply to given instruments, please refer to the page covering that instrument.

DISPLAY MONITORS

X-Y and Video: two basic types

Two basic types of displays are available: X-Y and Video (TV raster). In X-Y a spot is used to form a trace, moving randomly from point-to-point to form an image. In video, the beam scans the entire face of the CRT, one raster line at a time. Modulating the intensity of the beam as it moves produces the image.

Waveform, vector and dot scans are most commonly associated with X-Y displays, although these scans may be generated on video displays. Conversely, raster scan displays may be generated by X-Y. Trade-offs involve such factors as price/performance, brightness (better on video), bandwidth (broader on X-Y), and spot size.

"Gray scale capability" is the ability to accurately reproduce different light levels. At present, there are several standards for judging gray scale display. Some define each light "level" that makes up the "scale" as the brightness change discernible by the eye (typically a 3%-5% change). Another, less subjective, defines gray scale as the difference in brightness required to produce a specified density change on processed film.

Regardless of the gray scale standard used to differentiate one level from the next, the total number of levels depends on the contrast ratio — the difference between maximum brightness and minimum brightness. The greater this "dynamic range," the more levels will be displayed. Tektronix offers a wide selection of monitors optimized for gray scale.

Image Characteristics

Elements that may be important to you in obtaining the best image from a display monitor include the brightness of the image, the resolution or spot diameter, the size of the image and the phosphor type used and its characteristics.

Brightness depends on the type of crt used, the phosphor and the accelerating voltage. In general, higher brightnesses can only be obtained at the cost of lower resolution or slower writing speed. On some monitors, a separate intensity or Z-axis input is available to modulate the brightness of the beam. Resolution is specified either by spot size or by number of line pairs in a given distance. Smaller spot sizes or greater numbers of line pairs in general mean a more detailed image can be displayed.

Screen size and the size of the graticule on conventional monitors is normally comparable to that offered on laboratory oscilloscopes (up to 8 x 10 cm). Tektronix also offers a series of displays with screen sizes of 19 and 25 inches. Phosphor characteristics can be selected to optimize viewing or photography and to match desired image decay rates. See the phosphor chart and following information.

Storage

Storage is an essential feature on monitors when the information to be presented is transitory or the image to be built up is too complex for the source to communicate all at one time. Tektronix offers both bistable storage monitors and variable persistence models. See page 62.

Vertical and Horizontal Amplifiers

The amplifiers in display monitors must faithfully translate the input signal to a deflection on the CRT screen. Two important characteristics are the bandwidth of the amplifier and the linearity, each of which contributes to how faithfully the signal will be reproduced on the screen. The phase difference and the common-mode rejection ratio determine how closely two signals can be graphed against one another and how well they can be extracted from extraneous background noise. See the amplifier considerations section on the next page for further details.

CATHODE-RAY TUBE PHOSPHOR DATA

HUMAN EYE RESPONSE

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wavelength from deep red to violet. The human eye is most sensitive to the yellow-green region; however, its responsiveness diminishes on either side in the orange-yellow area and the blue-violet region. The eye is not very receptive to deep blue or red.

If the quantity of light falling on the eye is doubled, the brightness "seen" by the eye does not double. The brightness of a color tone as seen is approximately proportional to the log of energy of the stimulus.

The term **luminance** is the photometric equivalent of brightness. It is based on measurements made with a sensor having a

COMPARATIVE CRT PHOSPHOR DATA

Phosphor	Fluorescence	Phosphorescence Where Different from Fluorescence	Relative Luminance[1]	Relative Photographic Writing Speed[2]	Decay	Relative Burn Resistance	Comments	Ordering Information Option
P1	Yellowish-green	—	50%	20%	Medium	Medium	Replaced by P31 in most applications	Special order
P4	White	—	50%	40%	Med-Short	Medium high	Television displays	74
P7	Blue	Yellowish-green	35%	75%	Long	Medium	Long decay, double-layer screen	76
P11	Purplish-blue	—	15%	100%	Med-Short	Medium	For photographic applications	78
P31	Yellowish-green	—	100%	50%	Med-Short	High	General purposes, brightest available phosphor	80
P39	Yellowish-green	—	27%	NA[4]	Long	Medium	Photographic applications	40
P43	Yellowish-green		40%	NA[4]	Medium	Very High	High current density phosphor	Special order
P44	Yellowish-green		68%	NA[4]	Medium	High	Bistable storage	
P45	White	—	32%	NA[4]	Medium	Very High	Monochrome TV displays	

[1]Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.

[2]P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

[3]Low level lasts over one minute under conditions of low ambient illumination.

[4]Not available.

spectral sensitivity curve corrected to that of the average human eye. The SI (international metric standard) units for luminance are candelas per meter squared, but the English footlamberts are still used extensively in the U.S. One footlambert = 3.43 candelas/m². The term **luminance** implies that data has been measured or corrected to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de L'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful only when the phosphor is being viewed.

PHOSPHOR PROTECTION

When a phosphor is excited by an electron beam with an excessively high current density, a permanent loss of phosphor efficiency may occur. The light output of the damaged phosphor will be reduced, and in extreme cases complete destruction of the phosphor may result. Darkening or burning occurs when the heat developed by electron bombardment cannot be dissipated rapidly enough by the phosphor.

The two most important and controllable factors affecting the occurrence of burning are **beam-current density** (controllable with the Intensity, Focus, and Astigmatism controls) and the length of **time** the beam excites a given section of the phosphor (controllable with the Time/Div control). Of the total energy from the beam, 90% is converted to heat and 10% to light. A phosphor must radiate the light and dissipate the heat, or like any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping the intensity down or the time short will save the screen.

SELECTING A PHOSPHOR

The catalog description of each oscilloscope indicates the phosphor normally supplied or offered as an option. Special phosphors are available for applications which require different characteristics. For example, P11 is excellent for waveform photography but due to its short persistence it is not well suited for applications requiring visual observation of low-speed phenomena. For more specific information regarding the best-suited phosphor for your particular applications, please confer with your Tektronix Sales Engineer, Representative or Distributor. They know the factors that must be considered in selection of a phosphor for any given application.

Phosphors are rated in several parameters, such as color of fluorescence or phosphorescence, decay, etc. The table on page 15 describes the more commonly used phosphors.

SIGNAL PROCESSING SYSTEMS

WAVEFORM DIGITIZERS

Waveform digitizers convert analog waveforms to a series of discrete, time-related numbers representing signal amplitude. As a series of numbers, waveforms can be stored in a digital memory and recalled at any time for display on a graphic terminal or other such device. More importantly, these digitized waveforms can be transferred from instrument memory to a variety of processing units, ranging from microcomputers to full-sized computers, for complete waveform analysis. The benefits of this are increased measurement accuracy, repeatability, and throughput.

PROGRAMMABILITY

Instrument programmability is a significant feature when considering either remote or automated measurements. Offered with most GPIB products, it can range from transferring waveform data by a single command to complete instrument operation under program control.

KEY SPECIFICATIONS AND FEATURES

for oscilloscopes and related equipment

AMPLIFIER CONSIDERATIONS

RISE TIME AND BANDWIDTH

Two vital capabilities generally sought in an oscilloscope are sufficient bandwidth and adequate rise time.

Although rise time is usually the more important parameter when working with faster waveforms, signal bandwidth is commonly specified for lower speeds. Constraints make the two numerically related in well-designed general-purpose oscilloscopes. Bandwidth in megahertz multiplied by rise time in nanoseconds is approximately 0.35. Therefore, if your needs are defined in terms of one factor, dividing it into 0.35 will produce the other.

Bandwidth is defined as the frequency range in which signals are handled with less than a 3 dB loss compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, bandwidth here commonly refers to the highest frequency which can be displayed with a 3 dB or less error.

Most oscilloscope designs make use of gradual roll-offs at the high-frequency end, so in many cases a scope will be useful far beyond its specified bandwidth. Waveshapes may be altered and amplitudes reduced somewhat.

In terms of rise time, scopes ideally should have a vertical system capable of responding at least five times as fast as the fastest applied step signal (thus having a rise time less than 1/5 as great). In such a case, the rise time of the signal indicated on the scope will be in error by less than 2 percent.

Using the 1/5 and 0.35 factors together, the minimal requirements for scope bandwidth for accurate rise time measurements can be estimated using the following rule of thumb:

$$\text{Bandwidth (minimal)} \approx \frac{1.70}{\text{Fastest Rise Time}}$$

Very accurate absolute rise time measurements are not always important. When simply comparing the rise times of two signals, scopes with a rise time equal to the rise time of the signals applied are usually considered adequate.

Besides indicating bandwidth for the vertical channel, many oscilloscope specifications also include a bandwidth figure for the horizontal and trigger channels.

Bandwidth and rise time figures also apply to many other Tektronix instruments. Signal sources, probes, amplifiers, TDR systems and many other test instruments are characterized in part by rise time. Frequency response figures are given for portable patient monitors, spectrum analyzers and many TV products. The specifications will indicate values where these figures are relevant.

SENSITIVITY (DEFLECTION FACTORS)

Although sensitivity specifications are most often associated with oscilloscope vertical channels, specifications can also be provided for horizontal channels and trigger circuits with external inputs. Similarly, various other instruments may have a sensitivity specification relating minimum input level to some function or output level.

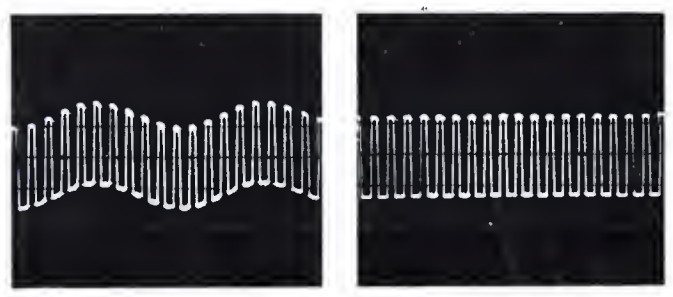
Sensitivity, in the case of oscilloscopes, refers to the input needed to produce a stated deflection of the spot on the CRT. Specifications typically are given in millivolts per centimeter or division.

At a given state of the art, sensitivity is a trade-off with bandwidth. The small amount of noise in even the best input circuit will mask signals which are too weak. Raising the bandwidth increases the noise picked up by the amplifiers, requiring more of a signal to create a clear display.

As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make better low-level, moderate frequency measurements. For these and other models, a set of sensitivity specifications may be given for limited frequencies as well as over the full range.

Many times, external noise will be the problem. Differential amplifiers are often used to lessen the effects of external noise and common-mode signals, thus improving the useful measurement sensitivity range.

DIFFERENTIAL, BALANCED, OR PUSH-PULL INPUTS



Differential or balanced amplifiers provide a feature beyond mere accommodation of push-pull signals: they have the ability to

cancel or reject, to a high degree, any signal components equal in amplitude and phase that appear at both inputs. Such amplifiers provide a simple and accurate means of measuring the difference between two signals. They also provide a means of rejecting most unwanted signal components common to both inputs, such as power line "hum."

MULTIPLE INPUTS

It is quite often useful to be able to view any one or several of a number of input signals without disturbing connections to the oscilloscope. Several types of multiple-input amplifiers which display more than one signal on the same crt display are available.

Common applications include input-output comparisons, checking a signal against a standard or working with complex circuits.

Dual-Beam and Dual-Trace

Two techniques, dual-trace or dual-beam circuitry, are commonly used for creating two traces on a single CRT. The dual-trace scope incorporates electronic switching to alternately connect two input signals to a single deflection system. The dual-beam scope, however, has two independent deflection systems within its CRT. (Some models do share horizontal systems, though.) There are distinct advantages to both dual-beam and dual-trace scopes. A dual-beam scope can display two input signals separately and simultaneously. Therefore, it can show two nonrecurrent signals of short duration. Also, models with independent horizontal deflection can display nonrecurrent signals on different time bases.

The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities. This comes from using a single horizontal amplifier and one set of deflection plates. On the other hand, since a transient event might occur on one input channel while the beam is tracing the other, dual-trace scopes are not recommended for viewing fast one-shot phenomena.

Extension of the dual-trace principles has produced newer multiple-trace oscilloscopes capable of displaying up to eight traces.

Tektronix Logic Analyzers display up to 16 channels of timing data, and can acquire up to 52 channels of state information.

TIME BASES

SWEEP RATES AND SWEEP TYPES

Except in special cases, oscilloscopes have built-in sawtooth sweep generators for producing constant-speed horizontal beam deflection. In early scopes, these generators ran continuously and horizontal calibration was based on their repetition frequency. In most modern scopes, sweeps are calibrated in terms of a direct unit of time for a given distance of spot travel across the screen; hence the term, "time base."

This technique permits:

1. Direct measurement of time between events.
2. Viewing and measuring small portions of pulse trains.
3. Viewing and measuring random or aperiodic events.
4. Viewing and measuring single nonrecurrent events.

Distances representing time are measured on the scope's graticule, the ruled scale built into the display. The internal graticule built inside the CRT face on modern scopes is preferable, as it eliminates parallax.

A major graticule division may be an inch, centimeter or some other length. Some instruments have different distance-units for the vertical and horizontal scales. Graticules often have small markings which subdivide the major divisions to assist in making accurate measurements. Such subdivisions should not be interpreted as the distance unit in a specification.

Strictly speaking, sweep specifications are rates properly expressed as time/length. However, the term **sweep speed** (implying length/time) is often used synonymously.

RELATING SWEEP RATES, HIGH FREQUENCIES AND RISE TIMES

The appropriate sweep rate for frequency-specified measurements is based on the nature of the test. Given a moderate frequency, a sweep is usually considered adequate if it is capable of displaying one cycle across the full horizontal scale. At high frequencies, however, scopes seldom have sweeps that fast. To measure rise time as accurately as possible, a step signal (square wave, rectangular pulse, etc) should occupy most of the full vertical scale, and the rising portion of the signal should be displayed at nearly a 45° slope. This objective can be met only if the fastest sweep is able to move the beam a horizontal distance nearly equal to the full vertical scale in a time interval equal to the rise time of the vertical deflection system. Because of the compounding difficulties and cost of providing extremely fast sweeps which are both linear and accurate, this goal must be tempered somewhat in scopes having the very best vertical deflection system rise time capabilities.

In some cases rise time measurements are not made to determine actual rise time, but are done to decide whether certain limits are met or exceeded. In such cases, an adequate comparison with a standard signal of known rise time can usually be made even with a sweep that provides a fairly steep display, given that the vertical deflection system rise time is good enough.

DELAYING/DELAYED TIME BASES

Delaying-sweep measurements use two linear calibrated time bases. The first time base, commonly called the delaying sweep, allows the operator to select a specific delay time. When this time is reached, the second time base, called the delayed sweep, starts. The delayed sweep is typically set a decade or two faster than the delaying sweep and therefore offers additional resolution. The combination of these two time bases also offers increased accuracy of time interval measurement.

DIGITAL TIME DISPLAYS

You can make delay and interval time measurements with digital ease on several Tektronix Oscilloscopes. The DM44 option for the 400 Series allow you to read the delay time, interval frequency, or temperature right from an LED readout, with no calculation or interpolation required. The 7B10, 7B15, 7B85 and 7B80 Plug-ins for 7000 Series Oscilloscopes provide Δ time (dual-delayed sweep) measurements. With this feature, both ends of the selected interval which can be independently positioned on the trace are shown by intensified regions. The time interval between those points is shown on the screen using the 7000 Series CRT readout capability.

SAMPLING

Sampling is a powerful technique for examining very fast repetitive signals. It is similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown, all seemingly at one time, on the screen of a cathode-ray tube. The graph thus produces a replica of the sampled waveforms. The principal difference in appearance between displays made by sampling techniques and conventional displays is that those made by sampling are comprised of separate segments or dots. This technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal recurs.

The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way. The system is capable of resolving events that occur in less than 30 picoseconds on an "equivalent" time base of less than 20 picoseconds per division and less than 5 mV of peak amplitude.

Tektronix uses the random sampling technique which differs from conventional sampling because it does not require a delay line or pretrigger for lead time to be visible in the display. The benefits afforded by this feature are:

1. Signals with no source of pretrigger can be observed.
2. The inherent rise time limitation of signal delay lines is eliminated.
3. It is no longer necessary to work into the 50 Ω characteristic impedance of a delay line, so high impedance can be retained.
4. External triggers may occur before, coincident with, or after the displayed signal, with lead time still visible in the display.
5. Display time jitter otherwise caused by pretrigger-to-signal jitter is eliminated.

Microcomputer Development Labs

MDL Now Supports

8088	6802
8086	6803
8085A	6808
8080A	F8
8048	3870
8049	3872
8035	3874
8039	3876
8039-6	Z-80A
8021	Z8000
8022	TMS9900
8041A	SBP9900
68000	1802
6800	6500/1
6801	

. . . with more to come

Tektronix Microcomputer Development Labs offer the broadest range of quality multiple microprocessor support available today. Tektronix won't lock you into one microprocessor family or vendor. Plus, every Tektronix MDL is backed with over 30 years of design experience. We test our Development Labs thoroughly to ensure performance and reliability. Each one provides complete development capability and the Tektronix committment that guarantees you'll keep abreast of the fast paced microprocessor technology.

Call your local specialist today to find out more about the new Tektronix 8550 MDL. Tektronix can also offer you high level language support with our Modular Development Language MDL/μ.

8001

Multiple Microprocessor Support

In-Circuit Emulation

Real-Time Prototype Analysis

The 8001 Microprocessor Lab is a total hardware debugging system for the design of microprocessor-based products. A key feature is its ability to support many microprocessor chips, including the 8086, 8041A, 8022, 8085A, 8080A, 8048, 8049, 8039, 8039-6, 8035 and 8021, 6800 and 6802, TMS9900, Z-80A, and Z8000, F8, 1802 and the 3870 and 3872, 3874, 3876 and 6500/1.

In addition to multiple microprocessor support, the 8001 offers three emulation modes for software debugging, partial and full emulation, as well as a real-time prototype analyzer option offering all the capabilities of a microprocessor analyzer with eight channels of external input.

The 8001 Microprocessor Lab consists of the 8001 Mainframe with 16K of Program Memory. Microprocessor Support Packages for microprocessors are optional. A Microprocessor Support Package includes an emulator ROM, an emulator processor, and a prototype control probe. The 4024/4025 Computer Display Terminals, or the LP8200 Line Printer are recommended optional peripherals.

Three Emulation Modes

In a typical design sequence, software is first developed independently using timesharing, a minicomputer, another development system, or some other means. It is then downloaded to the 8001 using the Tektronix Hexadecimal File Format to insure accurate transfer of the program. At this point the in-prototype emulation and software/hardware integration capabilities of the 8001 come into play.

After the developed software is downloaded to the 8001, the resulting object code may be executed in system emulation mode 0 on the optional emulator processor. The emulator processor is identical to the microprocessor that will finally be installed in the user's prototype. Execution is performed under control of the debug system; during execution, program steps can be traced, software breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the editing, assembling and linking feature of the host computer. This continues until the program is correct.

Partial emulation mode 1 lets the user release control in methodical steps from the 8001 to the prototype. The developmental software runs using 8001 memory space, and the prototype's I/O and clock. The 8001 memory mapping feature allows memory to be gradually mapped over to the prototype in address blocks as small as 128 bytes. Throughout partial emulation, the user has access to prototype circuitry via the powerful 8001 debugging system, which enables him to trace, set breakpoints, examine and change memory and register contents.

Full emulation mode 2 lets the user exercise the program on the prototype while still maintaining complete control through the Microprocessor Lab. All I/O and timing functions are directed by the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor. Although the prototype is effectively free-standing, the user may still direct program activity through the prototype control probe.

PROM Programmer

The 1702 and 2704/2708 PROM Programmer, Options 47 and 48 for the 8002A and 8001 Microprocessor Labs, provide the ability to program either 1702 or 2704/2708 erasable PROM chips. When the module is installed in an 8002A or 8001 Mainframe, the PROM Programmer software enables communication between 8002A or 8001 program memory and the PROM installed in the front-panel PROM programming porch.

1702 or 2704/2708 PROM Programmer software transfers one data byte at a time, and actual addresses are assigned. Data may be written from 8002A or 8001 program memory (WPROM); read from PROM into program memory (RPROM); or compared on the system terminal (CPROM).

The RPROM command allows the programmed PROM to be read into program memory and dumped to the system console. The CPROM compare function performs an address-by-address comparison between the PROM and the program under development. When an inequality between PROM bytes and memory bytes occurs, the memory address, memory byte content, and PROM byte content are displayed on the system console. A successful comparison between designated PROM and memory bytes is indicated by an End of Job message on the console.

8001 CHARACTERISTICS

The 8001 Microprocessor Lab is a modular system whose mainframe houses up to 20 plug-in circuit boards. Emulator processor modules for the microprocessor of choice, its associated prototype control probe, and a ROM-based software module are optional. A terminal is necessary for system operation, and may be ordered as an optional peripheral.

The Real-Time Prototype Analyzer module, additional 16K byte Program Memory modules, and PROM Programmer modules for the 1702 or 2704/2708 are available as system options.

In addition to the standard system console I/O port, the 8001 provides a system communication module with three RS-232-C compatible ports for use with such peripherals as paper tape reader/punchers, line printers (LP8200), printing terminals, modems and other peripherals. One port is designated a general purpose RS-232-C compatible input/output port with independent input and output baud rate selection. Another port is an RS-232-C compatible output only port for use with line printers. The third port is a modem compatible port for use with half duplex modems. All ports have strap selectable baud rates of 110, 300, 600, 1200, or 2400.

8001 PHYSICAL CHARACTERISTICS

Dimensions	in	cm
Height	9.6	24.7
Width	18.8	48.3
Length	22.3	57.3
Weight	**lb**	**kg**
Net	66	30

8001 ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +35°C (+32°F to 95°F).
Humidity	To 90° relative noncondensing.
Altitude	
Operating	To 15,000 feet max.

8001 ELECTRICAL CHARACTERISTICS

Ac Input Voltages	115 V ac ±10% or 230 V ac ±10%.
Frequency Range	60 Hz (50 Hz special order)

Microcomputer Development Lab System

8550

Multiple Microprocessor Support

In-Circuit Emulation

Real-Time Prototype Analysis

The Tektronix 8550 Microcomputer Development Lab is a versatile software development and hardware/software integration system for microcomputer-based product design. The system supports many 8- and 16-bit microprocessors, allowing the user to configure the 8550 for a wide variety of design types.

The 8550 Development Lab offers resources for editing facilities to support both assembly-level and high-level languages, as well as linking capabilities. The optional advanced CRT-oriented editor eases the task of program entry and editing. With the appropriate assembler and emulator options for the target microprocessor, the user can execute software in the 8550 for full program debugging.

The Lab also offers complete in-circuit emulation and hardware testing capabilities. With the appropriate prototype control probe for the target microprocessor, the user can transfer control from the 8550 to the prototype block by block, dedugging at every stage. The real-time prototype analyzer option provides an invaluable tool for verifying and correcting execution of the program in real time.

The basic 8550 system consists of two major components, the 8301 Microprocessor Development Unit and 8501 Data Management Unit. The Microprocessor Development Unit houses the operating system software, D0S/50; 32K bytes of program memory; language processor; emulator controller; and hardware options such as emulator processors and prototype control probes for selected microprocessors, an additional 32K of static RAM, the real-time prototype analyzer, and the PROM programmer. Optional system software includes assemblers for all supported microprocessors, Pascal and MDL/u compilers for several supported microprocessors, and the advanced CRT-oriented editor.

The Data Management Unit handles files and auxiliary I/O for DOS/50 and manages the movement of user files between its dual-sided, double-density flexible discs and the Microprocessor Development Unit. Disc memory capacity is 2 megabytes.

Multiple Microprocessor Support

A key feature of the 8550 is its ability to support many microprocessor chips, including the 8086, 8085A, 8080A, 8048, 8049, 8035, 8039, 8039-6, 8021, 8041A, 8022, 6800, 6802, 6808, F8, 3870, 3872, 3874, 3876, Z8000, Z80A, TMS9900, 1802 and 6500/1.

Program Development

Under the supervision of the operating system software, the Microcomputer Development Lab aids the designer in all phases of program development and debugging.

D0S/50 supervises the following tasks:

- General input and output.
- File creation and maintenance.
- Program assembly and compilation.
- Program execution, monitoring, and debugging.

Program entry and editing is accomplished via the standard line-oriented editor or the optional advanced screen-oriented editor, which allows both line-and screen-oriented editing.

Data management is simplified through a tree-like structure format, which allows the user to specify one main system directory, one root directory for each disc, and any number of sub-directories under the root directory. Data files may be created and entered directly into the root directory. As files are accumulated, the user may organize them into specific groups, each under its own specific directory. This allows the user to create directories within directories to any level of nesting needed.

The assembler processor, with the appropriate disc inserted in the flexible disc drive, performs program assembly functions for each microprocessor supported by the 8550.

The powerful macro capability allows the designer to access frequently used sets of code by referencing the macro by name. The linker, working with the relocating features of the Assembler, links and locates multiple code segments into a complete executable program. Additionally, the conditional assembler capability of the 8550 allows the designer to customize the final program by testing conditions to determine which of certain code segments are to be assembled into the final program. Code management is further enhanced by the Assembler's versatile string handling capability. Extension English language diagnostics of the 8550 provide easy to understand error messages and locate the line in which the error has occurred. When assembly is completed, the assembled object code is stored on disc in a newly created binary format file.

Three Emulation Modes

After an error-free assembly listing has been obtained, the resulting object code may be executed in system emulation mode 0 on the optional emulator processor. The emulator processor is identical to the microprocessor that will finally be installed in the user's prototype. Execution is performed under control of the debug system; during execution, program steps can be traced, software breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the text editor. It can then be reassembled and executed again. This procedure continues until the program is correct.

After the software has been debugged, it may be exercised on the prototype circuitry in the partial emulation mode (mode 1). During partial emulation, control may be released from the 8550 to the prototype in stages. The developmental software runs using 8550 memory space and prototype I/O and clock. The 8550 memory mapping feature allows memory to be gradually mapped over to the prototype in 128-byte address blocks. Throughout partial emulation, the user has access to prototype circuitry through the debugging system, which enables him, as before, to trace, set breakpoints, examine and change memory and register contents.

In full emulation (mode 2) the program is run on the prototype, but program execution is still under the complete control of the debug system. All I/O and timing functions are directed by the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor. Although the prototype is effectively free-standing, then, the user may still direct program activity from the 8550.

8550 Parts and Functions

Real-Time Prototype Analyzer

The real-time prototype analyzer option is useful for resolving timing problems in the prototype. This hardware trace function captures bus information from the program as it executes. It can store this information and display it later in trace format, or it can use the information to trigger a break in execution, time a program segment, or signal an external device usch as a logic analyzer.

8550 Parts and Functions

Refer to Figure 1 for the functional block diagram of the complete 8550 Microcomputer Development Lab system.

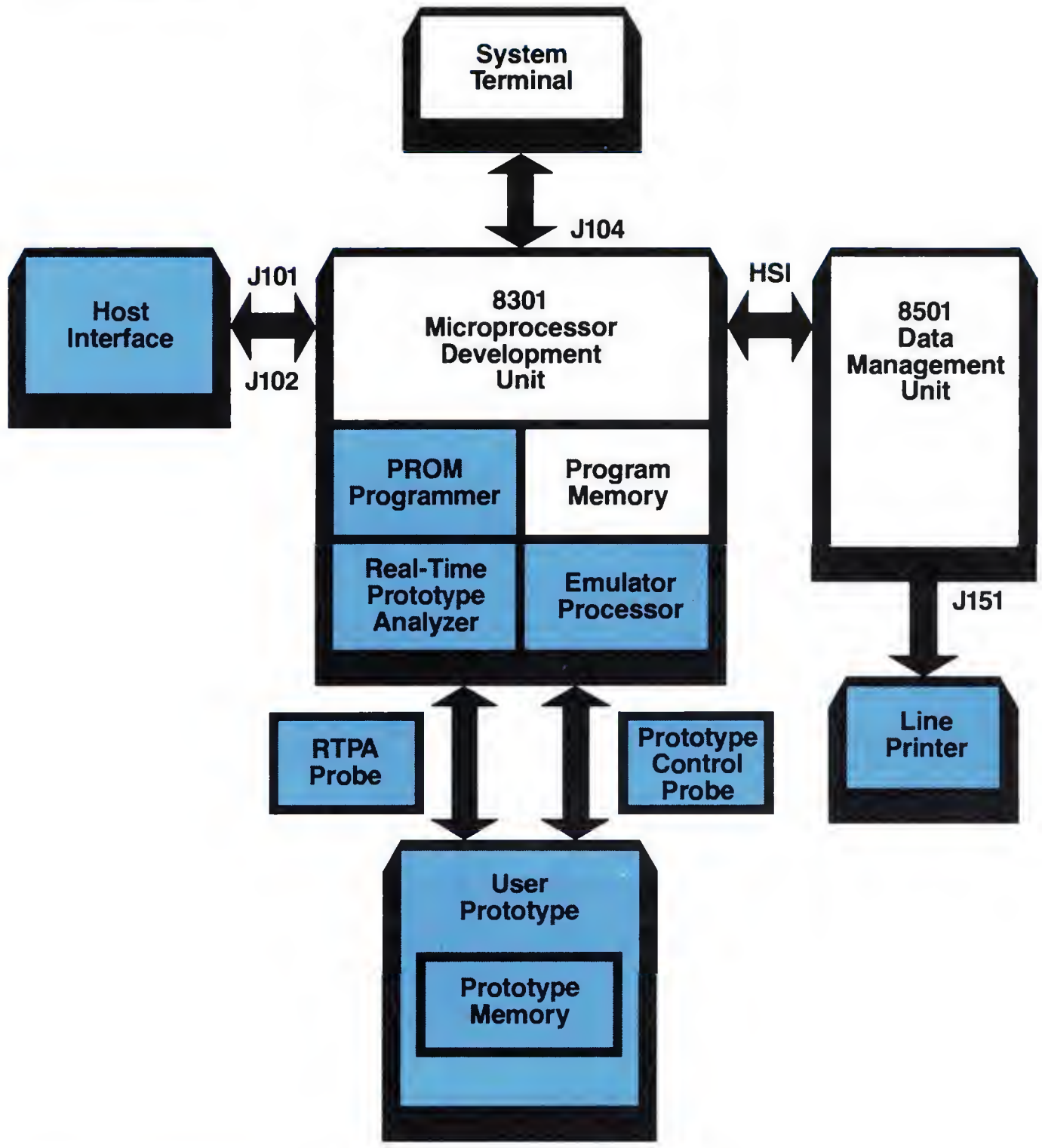


Figure 1 shows the components of a complete 8550 Microcomputer Development Lab system.

8550 CHARACTERISTICS

8301 MICROPROCESSOR DEVELOPMENT UNIT

Physical

Height	11 in	(280 mm)
Width	17 in	(430 mm)
Length	23 in	(585 mm)
Net Weight	60 lbs	(27 kg)

ENVIRONMENTAL

Operating Temperature	32°F to 122°F (0°C to 50°C)
Humidity	90% @ 86°F to 140°F (30°C to 60°C)
Altitude	
Operating	0 to 15,000 ft (4,500 m)
Storage	0 to 50,000 ft (15,000 m)

POWER REQUIREMENTS

115 V ac (90 V ac-132 V ac) @ 48 to 66 Hz.
230 V ac (180 V ac-250 V) @ 48 to 66 Hz.

Outputs

5.2 V dc +1%/-2% @ 35.0A
+12 V dc +0/-5% @ 1.7A
−12 V dc +0/-5% @ 1.7A

8501 DATA MANAGEMENT UNIT

Physical

Height	10.5 in	(267 mm)
Width	16.8 in	(424 mm)
Length	23.5 in	(597 mm)
Net Weight	55 lb	(25 kg)

ENVIRONMENTAL

Operating Temperature	50°F to 104°F (10°C to 40°C)
Humidity	20% to 80% relative noncondensing
Altitude	
Operating	0 to 8,000 ft (2500 m) Derate max operating temp. by 1°C for each 300 m above 2400 m.
Storage	0 to 50,000 ft (15,000 m)

POWER REQUIREMENTS

115 V ac (90-127 V RMS) @ 50 Hz ±1% or 60 Hz ±1%.
230 V ac (180-250 V RMS) @ 50 Hz ±1% or 60 Hz ±1%.

Outputs

24 V dc ±5% @ 2A
12 V dc ±3% @ 4A
−12 V dc ±5% @ 540 mA
5 V dc ±5% @ 20 A
15 V dc ±10% @ 20 mA

Output Ripple

24 V dc	100 mV (p-p)
±12 V dc	120 mV (p-p)
15 V dc	50 mV (p-p)
15 V dc	100 mV (p-p)

Overload Protection

Automatic current limit foldback.

FLEX DISC CHARACTERISTICS

Encoding — IBM compatible single or double density. Format must qualify as follows: MFM sectors—256 bytes. FM sectors—128 bytes.

Diskette Type — Single or double sided, soft sectored.

Capacity —

Double sided, double density 1,021,696 bytes.

Single sided, double density 509,184 bytes.

Single sided, single density 256,256 bytes.

Microprocessor Development Lab and Software Support

16-Bit Assembler and Prototype Debug Support

The 8086 and Z8000 Assemblers and 8086 Prototype Debug package are software products intended for use with the Tektronix 8550 Microcomputer Development Lab. The Assemblers support any software development effort targeted for the Intel 8086 or 8088 microprocessor or Zilog Z8002, while the Debug package will support the Intel iSBC 86/12A™.

In a typical design situation, the Assembler and Debug software is used in the following manner: First, an absolute object code file is generated by the Assembler or modules are linked to form a load file. Next, the file is downloaded to the SBC under control of the debug software, which supplies the protocol necessary for the serial transfer. This hardware link is accomplished through an RS-232 interface between the 8550's systems communication module and the SBC's serial data port. The 180 cm (6 ft) interface cable is supplied as part of the package. With the download complete, debug commands are entered through the 8550 system console and executed by interaction between two software components, one resident in the 8550 and the other on board the SBC. Both of these components are supplied as part of the debug package.

The Assembler

The Assembler supports software development by converting source code into executable object code, using a source file that has been created through the editing software. It will assemble code within an address range of 0 to 64K bytes, which allows full use of the memory space on the iSBC 86/12A.

Included with the assembler are a powerful set of macro features which allow the expansion of in-line code. Among these are the ability to call macros through easily identificable names, and the inclusion of an indefinite number of arguments. Assembly time string manipulation is allowed, including the use of variable length strings both inside and outside of macros. There is also a group of commands which allow conditional assembly based on an IF/ELSE structure. If more than one object code module is used, the linker will combine the separate files into a single load file.

Prototype Debug

The Debug package supports hardware/software integration on the iSBC 86/12A through two operations. First, it allows assembled absolute object code or a linked load file from the 8550 to be serially downloaded to the SBC memory for execution by its 8086 processor. Second, it permits a wide range of debugging operations to occur while exercising the downloaded software on the SBC.

Program execution can take place in real-time with predetermined breakpoints, or in single instruction steps. During debugging, the user can examine and modify the contents of both the SBC memory and the processor registers. In addition, blocks of data can be moved from one set of memory locations to another. The memory can also be filled with a specified hex or ASCII string, or searched for the occurrence of a specified data pattern. The results of debugging can be saved by uploading the SBC memory contents to the 8550 for file storage.

8002A

Multiple Microprocessor Support

In-Circuit Emulation

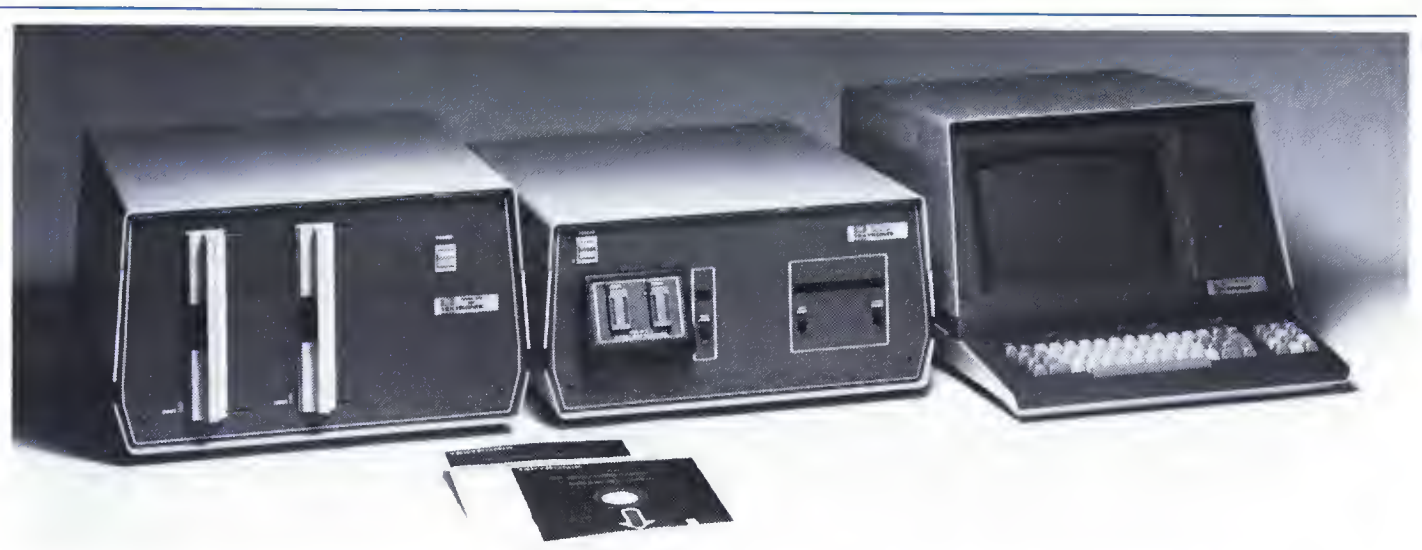
Real-Time Prototype Analysis

The 8002A Microprocessor Lab is a complete software development system for the design of microprocessor-based products. A key feature is its ability to support many microprocessor chips, including the Intel 8085A, 8080A, 8048, 8049, 8039, 8039-6, 8035 and 8021, Motorola 6800 and 6802, Texas Instruments TMS9900, Zilog Z-80A, Fairchild F8, RCA 1802, Mostek 3870/72, and the Rockwell 6500/1. The 8002A also supports the new 16-bit processors inciuding the Intel 8086/88, Zilog Z8000, and the Motorola 68000.

In addition to multiple microprocessor support, the 8002A offers a superior operating system and powerful text editor, assembler, and debugging programs; three optional levels of emulation for software debugging, partial and full emulation; and a real-time prototype analyzer option offering all the capabilities of a microprocessor analyzer with eight channels of external input.

Software Development and Debugging

In a typical design sequence, software is developed using all the resources of TEKDOS, the disc-operating system software for the 8002A Microprocessor Lab. TEKDOS performs flexible disc and file utility functions, data transfer functions, and system/peripheral device control functions. In addition to relieving the user of these housekeeping chores, TEKDOS also supervises the text editor, assembler, and linker programs and the optional emulation support, debugging system, and PROM programming routines.



Program entry and editing may be accomplished module by module. The line-oriented text editor offers several convenience features for preparing, correcting, and modifying the program quickly and easily.

The assembler processor, with the appropriate disc inserted in the flexible disc drive, performs program assembly functions for each microprocessor supported by the 8002A.

After an error-free assembly listing has been obtained, the resulting object code may be executed in system emulation mode 0 on the optional emulator processor.

Partial and Full Emulation

After the software has been debugged, it may be exercised on the prototype circuitry in the partial emulation mode (mode 1). During partial emulation, control may be released from the 8002A to the prototype in stages.

In full emulation (mode 2) the program is run on the prototype, but program execution is still under the complete control of the debug system. All I/O and timing functions are directed by the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor.

8002A CHARACTERISTICS

The 8002A Microprocessor Lab is a modular system whose mainframe houses up to 20 plug-in circuit boards. A terminal is necessary for system operation, and may be ordered as an optional peripheral.

The Real-Time Prototype Analyzer module, additional 16K byte Program Memory modules (Standard Program Memory consists of 32k bytes of RAM), and PROM Programmer modules for the 1702 or 2704/2708 are available as system options.

In addition to the standard system console I/O port, the 8002A provides a system communication module with three RS-232-C compatible ports for use with such peripherals as paper tape reader/punchers, line printers (LP8200), printing terminals (CT 8101) modems and other peripherals. One port is designated a general purpose RS-232-C compatible-input/output port with independent input and output baud rate selection. Another port is an RS-232-C compatable-output-only port for use with line printers. The third port is a modem-compatible port for use with half duplex modems. All ports have strap selectable baud rates of 110, 300, 600, 1200, or 2400.

Emulator Processor and Prototype Control Probe Support Packages

The 8550, 8002A, and 8001 Microcomputer Development Labs support a wide variety of different microprocessors and microcomputers.

Emulators are currently available for the Intel 8080A, 8085A, 8048, 8049, 8039, 8039-6, 8035 and 8021, Motorola 6800 and 6802, Texas Instruments TMS9900, Zilog Z-80A, Fairchild F8, RCA 1802, the Mostek 3870 and 3872, and Rockwell 6500/1.

Emulator packages for the 8002A and 8001 may be ordered as system options. These options provide the capabilities necessary to fully emulate the target microprocessor in a user's prototype system.

The emulator processor, which resides on a plug-in circuit module along with controlling logic circuitry, enables the user to execute and debug the program on a microprocessor identical to the one which will be used in the prototype, while giving him access to the full 64K bytes of Microprocessor Lab program memory.

The prototype control probe, which links the emulator processor to the prototype system, allows partial and full in-circuit emulation.

All emulation operations are controlled by the powerful Microprocessor Lab system software. The user is able to monitor program execution, set software breakpoints, examine and change memory and register contents. Debug trace information is displayed in a format unique to the microprocessor, with instruction fetches disassembled into mnemonics for easy interpretation.

8049, 8035, 8039, 8039-6, 8022, 8041A, 8048/8021 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8048, 8049, 8039, 8039-6, 8035, 8022, 8041A and 8021 are trademarks of Intel Corporation, Tektronix, Inc., does not guarantee that other vendor's versions of these microcomputers will be compatible with Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft. (1.8 m) of cable from the emulator processor to the interface assembly. 1.5 ft. (45 cm) of cable from the interface assembly to the 40-pin plug (or 28-pin plug for 8021).

Cable Configuration

6 ft. (1.8 m)

Two 40 conductor ribbon cables with alternating ground and signal paths.

1.5 ft. (45 cm)

Two laminated 40 conductor cables made up of signal-ground pairs.

(TYPICAL WORST CASE) EMULATION INTERFACE DELAYS FOR THE 8048 (8021 IF DIFFERENT)

		tPLH (ns) Typ. Worst Case	tPHL (ns) Typ. Worst Case
ALE		14,20	14,20
$\overline{PSEN}$		22,32	22,32
$\overline{RD}$,$\overline{WR}$		18,26	15,22
$\overline{PROG}$		14,20	14,20
D80-D87*** (P00-P07) User to CPU	t_1—fetch cycle t_2—execute cycle	,90 26,38	,90 26,38
D80-DB7 (P00-P07) CPU to User	t_3—Address Out t_4—Ext Data Out t_5—OUTL, ANL, ORL, data out	26,38 26,38 14,20	26,38 26,38 14,20
P10-P17 P24-P27		2,2	2,2
P20-P23			
TO**	out/in	11,15	11,15
T1			102,82
$\overline{INT}$		21,32	21,32
RST	8048 (8021)	(120,212)	69,122
SS		22,32	22,32
CLK		29,47	31,52

*INTEL 8099 chip specifications.

**for clock in to 8039 > 6 MHz and memory mapped to 8550, t0 out is divided by 2.

***tRD* = t 1.2 + t user mem access.

8041A PROTOTYPE CONTROL PROBE

(Typical, worst case) Emulation Interface Delays

	tPLH (ns) (typ. WC)	tPHL (ns) (typ. WC)
SYNC	14,20	14,20
$\overline{PROG}$	14,20	14,20
T1		27,39
P10-P17	2,2	2,2
T0	29,45	22,34

Symbol	Parameter	Min	Max	Units
tACC	$\overline{DACK}$ to $\overline{WR}$ or $\overline{RD}$	54		ns
tCAC	$\overline{RD}$ or $\overline{WR}$ to $\overline{DACK}$	71		ns
tACD	$\overline{DACK}$ to data valid		225	ns
tCRQ	$\overline{RD}$ or $\overline{WR}$ to $\overline{DRQ}$ cleared		200	ns
tAW	$\overline{CS}$,A0 Setup to $\overline{WR}$	0		ns
tWA	$\overline{CS}$,A0 Hold after $\overline{WR}$	24		ns
tWW	$\overline{WR}$ Pulse Width	250		ns
tDW	Data Setup to $\overline{WR}$	150		ns
tWD	Data Hold after $\overline{WR}$	70		ns

8022 PROTOTYPE CONTROL PROBE

8022 Timing Characteristics With Emulation Interface Delays

	tPLH (ns) typ. worst case	tPHL (ns) typ. worst case
ALE	24,34	32,46
P00-P07	54,87	57,91
P00-P07	1.3 μs	1.3 μs
P10-P17	t1—CPU to USER t2—USER to CPU } 2,2	2,2
P20-P23	for OUTL inst: data valid before ALE after the next instruction fetch. t3—MOVD P2, A 13,18 t4—MOVD A, P2 IN A, P2 } 13,18	17,24 17,24
$\overline{PROG}$	13,18	17,24
T0	17,24	17,24
T1	102,182	102,182
AN0,AN1	336,444	336,444
XTAL1	21,33	29,45

[1]Inputs must be present until read by an input instruction (Intel Specification).

Emulator Processor and Prototype Control Probe Support Packages

8080A EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8080 and 8080A refer to microprocessors manufactured by Intel Corporation. Tektronix, Inc., does not guarantee that other vendors' versions of the 8080 will be compatible with the Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

1.5 ft. (45.8 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40-conductor ribbon cables with alternating ground and signal paths.

1.5 ft (45.8 cm) — 2 twisted pair 40 conductor cables.

Termination

6 ft (1.8 m) — The interface assembly contains resistive termination and receivers for data, address, and control from the emulator processor module.

1.5 ft (45.8 cm) — Not terminated.

40 pin plug—40 pin spring plate protected plug. When used with a zero insertion force socket, an included 40 pin low profile DIP socket must be used between the zero insertion force socket and the 40 pin probe plug.

TIMING CHARACTERISTICS

Emulation Interface Delays*

To 8080A from Interface Assembly	Typ	Max (in ns)
ø1	44	60
ø2	44	60
HOLD	44	67
RESET	44	67
RDY**	35	40
INT	63	104
DATA	44	53

From 8080A to Interface Assembly	Typ	Max (in ns)
HOLDA***	39	55
SYNC	37	45
WAIT	37	45
WR	37	45
DBIN	37	45
INTE	39	55
ADDRESS	27	35
DATA	50	63

Assumes 6 ft of cable at 1.5 ns/ft.

***RDY is ignored unless user memory or I/O is accessed in control mode 2 or special mode.*

****The equation for HOLDA to tristate timing is as follows: HOLDA • DBIN = FLOAT. Tristate of data and address follows the trailing edges of DBIN or WR by approximately 20 ns.*

8085A EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8085 and 8085A refer to microprocessors manufactured by Intel Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the 8085 will be compatible with the Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

1 ft (30 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40-conductor ribbon cables with chassis ground plane and signal paths.

1 ft (30 cm) — 2 40-conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the 8085 emulator processor module.

1 ft (30 cm) — Not terminated.

AC CHARACTERISTICS

Emulation Clock

Mode 1 or Mode 2 (user's clock), with 8085A Prototype Control Probe.	6.25 MHz max*; crystal, RC timing network or TTL input to X1.
Mode 0 (system clock)	6.25 MHz ±0.01%

6800/6802 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

6800 and 6802 refer to microprocessors manufactured by Motorola Corporation. Tektronix, Inc., does not guarantee that other vendors' versions of the 6800 or 6802 will be compatible with the Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

1 ft (30 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40-conductor ribbon cables with alternating ground and signal paths.

1 ft (30 cm) — 2 twisted pair 40 conductor cables made up of signal/ground pairs.

6800 PROTOTYPE CONTROL PROBE

Read/Write Timing (In ns)

Characteristic	Symbol	Min	Typ	Max
Peripheral Read Access Time	^{D}TACC			506
Address Setup Time	^{D}TAD			350
R/W Setup Time	^{D}R/WSU			375
VMA Setup Time	^{D}EVMA			365
Data Setup Time (Read)	^{D}TDDR	119		
Data Delay Time (Write) (relative to 01↑)	^{T}DDW			513
Delay for DBE Rising Edge (relative to 01↑)	^{D}DBER			444
Input Data Hold Time	^{D}HRD	29		
Output Data Hold Time (after 01↑)	^{D}TDWH	40**	10	
Output Data Hold Time (after DBE↓)	^{D}TDWH	20		
Address Hold Time	^{D}ADH	65		
VMA Hold Time	^{D}VMAH	68		
R/W Hold Time	^{D}R/WH	61		

6802 PROTOTYPE CONTROL PROBE

Read/Write Timing (In ns)

Characteristic	Symbol	Min	Typ	Max
Peripheral Read Access Time	^{D}TACC			480
Address Setup Time	^{D}TAD			367
VMA Setup Time	^{D}EVMA			373
R/W Setup Time	^{D}R/WSU			392
Data Setup Time (Read)	^{D}TDDR	127		
Data Delay Time (Write)	^{T}DDW			527
Input Data Hold Time	^{D}HRD	40**	10	
Output Data Hold Time	^{D}TDWH	39		
Address Hold Time	^{D}ADH	63		
VMA Hold Time	^{D}VMAH	66		
R/W Hold Time	^{D}R/WH	70		

**Although data should remain valid at least 40 ns after Enable, typically 10 ns will be sufficient.

Z80A EMULATOR SUPPORT PACKAGE CHARACTERISTICS

Z80 and Z80A refer to microprocessors manufactured by Zilog Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the Z80 will be compatible with the Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processort to the Interface assembly.

1 ft (30 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft. (1.8) — 2 40-conductor ribbon cables with chassis ground plane and signal paths.

1 ft (30 cm) — 2 40-conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the Z80 Emulator Processor module.

1 ft (30 cm) — Not terminated.

TIMING CHARACTERISTICS

The Z80A Emulator Processor was designed to match the ac characteristics of the Z80A and Z80 Microprocessors.

TMS9900 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

TMS9900 refers to microprocessors manufactured by Texas Instruments Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the TMS9900 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

9.5 in (24.2 cm) of cable from the interface assembly to the 64 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40-conductor ribbon cables with chassis ground plane and signal paths.

9.5 in (24.2 cm) — 2 32-conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the TMS9900 emulator processor module.

9.5 in (24.2 m) — Not terminated.

TIMING CHARACTERISTICS

To TMS9900 from Interface Assembly	Emulation Typical	Interface Delays* Maximum (in ns)
ø1	41	59
ø2	41	59
ø3	41	59
ø4	41	59
CRUIN	12	23
INTREQ	12	18
IC0	12	23
IC1	12	23
IC2	12	23
IC3	12	23
HOLD	12	18
READY	12	18
LOAD	12	18
RESET	68	98
DATA	14	21

From TMS9900 to Interface Assembly	Typical	Maximum (in ns)
DBIN	24	41
MEMEN	12	18
WE	12	18
CRUCK	12	23
CRUOUT	12	23
HOLDA	12	23
WAIT	12	23
IAQ	12	23
ADDRESS	14	21
DATA	14	21

**Assumes 1.5 ft of cable at 1.5 ns/ft.*

Note: All inputs and outputs of the 64 pin plug at the end of the prototype control probe are buffered by 74LSXXX type devices. In all cases, data and control should not change during clock ø1.

6500/1 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

6500/1 is a trademark of Rockwell International Corporation. Tektronix, Inc. does not guarantee that other vendor's versions of these microcomputers will be compatible with Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length — 1.8 m (6 ft) of cable from the emulator processor to the interface assembly. 45 cm (1.5 ft) of cable from the interface assembly to the 40-pin plug.

Cable Configuration

1.8 m (6 ft) — Two 40 conductor ribbon cables with alternating ground and signal paths.

45 cm (1.5 ft) — Two laminated 40 conductor cables made up of signal-ground pairs.

TYP Delays In ns added to 6500/1E by Emulator with 6.8K Pull Up Resistors

		Output Driving	Input Receiving
PA0—PA7	RISING EDGE	1 CLK CYCLE +300	100
	FALLING EDGE	1 CLK CYCLE +300	100
PB0—PB7, PC0—PC7, PD0—PD7	RISING EDGE	300	*
	FALLING EDGE	30	*
CNTR	RISING EDGE	100	100
	FALLING EDGE	20	20

*Gated in only during a read instruction from 81, 82, 83.

F8, 3870, 3872 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

F8 refers to microprocessors manufactured by Fairchild's Corporation; the 3870 and 3872 refer to microcomputers manufactured by Mostek Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the F8, 3870, or 3872 will be compatible with the Tektronix Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from emulator processor to the interface assembly. 1 ft (30 cm) of cable from the interface to 40 pin plug.

Cable Configuration

6 ft (1.8 m) — Two 40-conductor ribbon cables with chassis ground plane and signal paths.

1 ft (30 cm) — Two 40-conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the F8/3870/3872 Emulator Processor module.

1 ft (30 cm)—Not terminated.

TIMING CHARACTERISTICS

3870/3872 — The 3870/3872 Prototype Control Probe was designed to meet all the ac characteristics of the 3870 and 3872 Microcomputers.

F8 (3850) — The F8 Prototype Control Probe meets all of the F8 ac characteristics with the following exceptions: (1) the worst-case delay from the falling edges of WRITE to the ROMC lines being valid is 650 ns (compared to 550 ns for the F8 CPU); (2) the worst-case skew between an external clock input is 0 to 90 ns longer than that specified for the F8.

1802 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

PHYSICAL CHARACTERISTICS

Length — 6 ft (1.8 m) of cable from the emulator processor to the interface assembly. 1.5 ft (45 cm) of cable from the interface assembly to the 40-pin plug.

Cable Configuration

6 ft (1.8 m) — Two 40-conductor ribbon cables with alternating ground and signal paths.

1.5 ft (45 cm) — Two laminated 40-conductor cables made up of signal-ground pairs.

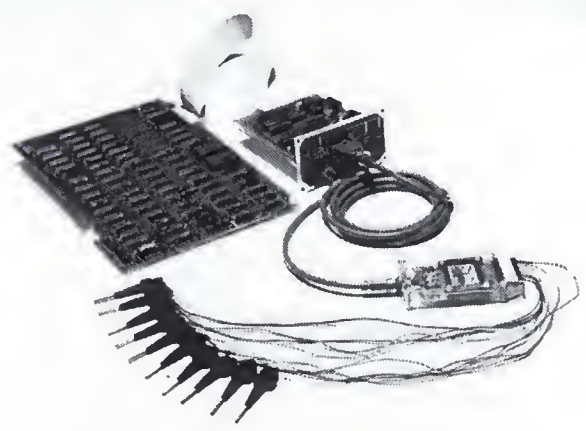
TIMING CHARACTERISTICS

The 1802 Prototype Control Probe is designed to meet all the ac characteristics of the 1802 Microprocessor —Vcc ≥4.0 V.

AC CHARACTERISTICS

Emulation Clock

Mode 1 or Mode 2 (user clock) with 1802 Prototype Control Probe.	5.0 MHz max at 10 Vcc. 25°C, this can be crystal, or external input to clock (pin 1).
Tracking power supply to monitor user voltage (Vcc) and run the probe at the same voltage (4 V to 12 V).	2.5 MHz



REAL-TIME PROTOTYPE ANALYZER

The Real-Time Prototype Analyzer, Option 46 for the 8001 and 8002A Microprocessor Labs, and Option 01 for the 8550 Microcomputer Development Lab, is comprised of a real-time trace module, a data acquisition interface, and an 8 channel general logic probe. This option provides a real-time trace of the user program executing on the emulator processor, with 43 channels of data acquired simultaneously. The prototype address bus, data bus, control bus, and any eight external locations on the prototype circuit may be monitored without slowing up the operational speed of the processor. The Real-Time Prototype Analyzer is indispensable when isolating critical timing errors and hardware/software sequence discrepancies during the final integration phases of prototype development.

The analyzer module is a separate plug-in circuit card that may be inserted into either the 8550 or 8001 system mainframe. The P6451 Probe connects to the prototype circuitry and permits data transference from the prototype to the analyzer. Data from the prototype is buffered and driven by the probe to the data acquisition interface, and then loaded into the analyzer module's real-time trace buffer.

As the user program executes on the emulator processor, 48 bit data words are sequentially acquired from the prototype and loaded into the real-time trace buffer. Each data word contains 16 bit data from the address bus; 8 bit or 16 bit data from the data bus; 8 bit data from the test probe; 3 bit data identifying cycle type (read, write, I/O, memory, or instruction fetch); and 5 bit data used internally to identify last start/stop of the emulator processor. The analyzer will continue to acquire these sequential cycles of logic input until the processor is stopped or the real-time trace buffer is frozen by a specified trigger occurrence. The real-time trace buffer can retain up to 128 data words in pre-, variable center, or post-trigger modes; thus enabling the storage of pertinent program bus transactions.

The Real-Time Prototype Analyzer offers expanded breakpoints to aid in efficient location of prototype problems. Two event comparators located within the analyzer module can be utilized to halt program execution and stop real-time trace. A trigger may be generated on any specific data occurrence in the address bus, data bus, test probe input, and instruction cycle type. Triggering may be immediate; delayed by counting the number of passes; or delayed by counting the number of clock select outputs (clock select may be by microseconds, milliseconds, emulator clocks, etc.). In addition, an output pulse may be generated, via the data acquisition interface, to trigger a logic analyzer or an oscilloscope.

The two event comparators (triggers) may be set to designate a break or halt in the program execution. These comparators may be used as independent breakpoints; or they may be used together to enable a breakpoint on a specific event combination. The program execution can be halted when two trigger events occur simultaneously; when one trigger event precedes another; or when either trigger event occurs. When a break in the program execution takes place, program transactions stored in the real-time trace buffer may be displayed or printed.

Data stored in the real-time trace buffer is displayed sequentially in the order it was acquired from the prototype. Buffer content may be displayed in whole or in part. Optional command parameters are available to limit the storing of data to any specific transaction type, such as memory reads only. If the total buffer contents are displayed, a blank line will separate the data sequence associated with each program starting point.

The Real-Time Prototype Analyzer features a convenient and easy-to-understand display format. With this format, the address location, data, probe input, and control bus data of each acquired transaction are displayed. If the transaction was an instruction fetch, the instruction is also disassembled into the appropriate mnemonic readout unique to the emulator type being used.

Prototype Analyzer, High Level Language

The Real-Time Prototype Analyzer functions in all emulation modes and operates with all commercial microprocessors supported by the 8550, 8002A and 8001 Microcomputer Labs.

REAL-TIME PROTOTYPE ANALYZER CHARACTERISTICS

OPERATIONAL SPEED CHARACTERISTICS

Processor	Maximum Processor Clock Rate*
8085A	3.125 MHz (internal clock)
8080A	2.08 MHz
6800/6802	1.00 MHz
Z80	4.00 MHz
TMS9900	3.33 MHz
3870/3872	4.00 MHz
F8	2.00 MHz
6500/1	1.00 MHz
1802	6.4 MHz

**Maximum processor clock rate for Real-Time Prototype Analyzer operation.*

INPUT/OUTPUT CHARACTERISTICS

Variable Threshold

Range	$>+10$ V dc to <-10 V dc
Preset TTL Voltage	$+1.4$ V dc ± 200 mV
Event Trigger Out	High level voltage out (when Vcc=Min, Vi=0.5, Ro=50 Ω to GND) is >2 V dc.

Adjustments—Variable Threshold may be adjusted from $>+10$ V dc to <-10 V dc with a screwdriver adjustment accessible at the rear panel of the Microcomputer Lab. This voltage must be monitored with a voltmeter having an input impedance of at least 10 MΩ.

Jumpers—With the internal jumper in position '0-3' the clock threshold is designated to be the same as channels 0-3. In position '4-7' the jumper designates the clock threshold to be the same as channels 4-7.

Cable Length — 50 cm (19.5 in).

MODULAR DEVELOPMENT LANGUAGE MDL/μ

MDL/μ is a high level language designed specifically for use in microprocessor-based design. Its parent language is ANSI Minimal BASIC, a widely used and well understood programming format. MDL/μ offers an extensive number of enhancements from BASIC that make this new language an extremely effective design tool while retaining the advantages of simplicity and easy learning found in BASIC.

One essential advantage of MDL/μ is that it uses a compiler instead of an interpreter. Each program statement is translated to machine code only once, instead of every time the statement is executed. The result is faster, and often more compact code for final program execution.

MDL/μ allows a module-oriented approach to software development. Two statements, USES and PROVIDES, allow variables, functions and procedures to be shared by programmers working on different modules of an overall program. The USES statement also allows direct access to absolute memory locations, I/O ports and interrupts—all essential for proper control of hardware/software integration.

Variable names and strings have been considerably expanded with MDL/μ. Variable names can contain up to six characters, the first alphabetic and the others alphanumeric, for easy identification during program development. Strings can vary in length from 1 to 255 characters instead of the unalterable 18 used in minimal BASIC. Substring replacement is also enhanced to assist in character manipulation.

I/O features include access to ports and absolute addressing of memory, which allows variables to be assigned a specific address. Both ASCII and general purpose binary file manipulations are possible through a series of I/O statements including OPEN, CLOSE, RESTORE, READ, WRITE, PRINT and INPUT.

Among many other MDL/μ enhancements to BASIC are logical operators (AND, OR, XOR, NOT) plus shift and rotate operations for bit manipulation, DISABLE and ENABLE to turn the interrupt off and on and a built in code optimization.

The conversion of MDL/μ source code to actual machine code is a three-step process. The first step converts MDL/μ source code into assembly language source code which is stored on a file or device. The assembly source code contains the original MDL/μ statements as comments preceding each block of assembly source code. At this stage, the assembly language can be further optimized by using the 8550's powerful editor. In the second step the assembler converts the assembly language source into object code. The third step is to link the object code with the run time support library and any other assembled object code modules.

PASCAL: HIGH-LEVEL PROGRAMMING LANGUAGE

Pascal, a high-level programming language, is receiving much attention in the electronics industry. Features such as program structure, strong data typing, and readability greatly enhance programmer efficiency, and thereby reduce software development and maintenance costs. The Tektronix Pascal 8080/8085 Compiler is designed specifically for those who are writing programs for the 8080 or 8085 microprocessors. The Tektronix Pascal 8080/8085 Compiler is a superset of the ISO draft standard Pascal. A true compiler rather than a P-code interpreter, the Pascal 8080/8085 Compiler generates object code directly. Each program statement is translated to machine code only once instead of every time the statement is executed, resulting in faster and often more compact code.

Standard Pascal Features

Pascal is a block-structured language that allows the program to be divided into subprograms called procedures and functions. This block structure encourages programmers to logically plan and construct programs, so debugging time is greatly reduced. The block structure also requires that all variable declarations occur prior to executable code.

Pascal's six control structures correspond closely with flowchart elements and make algorithm coding very natural. All control structures have a single entrance and exit unless GOTO's are used, so program modifications are unlikely to introduce errors into the program.

Pascal allows programmers to use many flexible forms of data representations and to define data types that accurately express their particular problems. Pascal also has strong data typing, which means that each variable must be defined as a single data type prior to its use and used consistently with its definitions.

Pascal programs are easy to read, and thus to maintain. Pascal differs from most line-oriented languages by allowing extra spaces, tabs, and carriage returns almost anywhere. Variable, procedure, and function names can be meaningful and easily understood because they are not restricted in length. However, identifiers used by TEKDOS must be unique in the first eight characters, other identifiers, in the first 19.

Tektronix Pascal 8080/8085 Compiler Major Extensions

Input/Output

Included with the Pascal 8080/8085 Compiler are several predefined procedures and functions used for chip-level I/O. A procedure to send data to a specified port and function to read data from a specified port are included. These procedures and functions are analogous to the standard Pascal WRITE, WRITELN, READ, READLN procedures, which are available for 8002A mode O operation when using TEKDOS I/O. All of the 8002A's I/O capability is available to a Pascal program running in emulation mode O, so the Pascal program can access the console terminal, discs, line printer, and auxilliary I/O ports. The Pascal 8080/8085 Compiler also allows an ORIGIN attribute to be associated with variables. The ORIGIN attribute assigns variables to specific memory addresses and is very useful for memory mapped I/O.

Interrupt Handling

The Pascal 8080/8085 Compiler supports full use of the 8080's and 8085's interrupts. The interrupts are supported by writing the interrupt service routine as a separate procedure having the INTERRUPT attribute. Separate routines are required to connect a specific interrupt vector to the appropriate interrupt service routine. The interrupt service routines are included as convenience routines with the compiler. Procedures are also supplied to set (SIM) and read (RIM), the 8085's interrupt mask.

Linkage to Assembly Routines

Speed-critical or timing-critical applications are likely to require some program segments to be written in assembly language. Because the code generated by the Pascal 8080/8085 Compiler is compatible with the 8002A linker, assembly code can be linked to Pascal code.

Separate Compilations

Separate compilations are supported by the Pascal 8080/8085 Compiler. The main program module's first word is the keyword "PROGRAM." Submodules to be separately compiled begin with the keyword "MODULE". Global variables, procedures, and functions can be referenced between separately compiled modules and the main program via PUBLIC and EXTERN attributes. The PUBLIC and EXTERN attributes are associated with variables, procedures, and functions and cause the compiler to generate the appropriate linker text.

Non-Decimal Integers

In many microcomputers applications, programmers want to use non-decimal integers. The Pascal 8080/8085 Compiler supports binary, octal, and hexadecimal integers for input and output.

ROM/RAM Applications

ROM/RAM applications are facilitated by control-section typing. Control-section typing means that the compiler gives the user the information he needs to allocate program variables into a linker section separate from literals, constants, and instructions, which are put into a second linker section.

Structured Constants

Standard Pascal allows only constants of type, integer, real, boolean, and text char. The Pascal 8080/8085 Compiler also provides constants which are arrays, and records. The most common application of structured constants is to initialize structured variables (arrays and records) that must reside in potentially volatile RAM.

Metacommands

Metacommands are compiler directives that cause the compiler to do such things as format the listings or generate run-time debugging code.

Tektronix offers maintenance training classes on Microcomputer Development Labs and a variety of user workshops featuring microprocessor hardware and software design concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

4024 Computer Display Terminal

The 4024 Computer Display Terminal is an optional peripheral recommended for use with the 8001 or 8002A Microcomputer Labs.

The 4024 Computer Display Terminal is serially interfaced to either Microprocessor Development Lab through an EIA standard RS-232-C port on the systems communications module. The 12 inch (30 cm) diagonal crt displays up to 34 lines of 80 characters each, and the keyboard contains a full ASCII set of characters in upper and lower case. Option 20 (8K bytes Program Memory) is required for proper 8001 and 8002A operation.

4024 Computer Display Terminal with Option 20* $3450

LP 8200 Line Printer

The LP 8200 Line Printer is an optional system peripheral for the 8002A and 8001 Microprocessor Labs.

The LP 8200 is serially interfaced to either Microprocessor Lab through an EIA standard RS-232-C port on the system communications module. Baud rates of 300 to 9600 are selectable.

The printout provides space for 132 characters/line, 6 lines/vertical inch. The full ASCII set of 96 upper/lower case characters is provided.

ELECTRICAL CHARACTERISTICS

Voltage	90 to 132 V ac standard*
Frequency	60 Hz ±1 Hz.
Power	400 W max (printing); 200 W max (idle).

PHYSICAL CHARACTERISTICS

Dimensions	**in**	**cm**
Height	33.5	85.09
Width	27.5	69.85
Length	21.7	55.12
Weight	**lb**	**kg**
Net	102	46.4

LP 8200 Line Printer $3765

*Alternate line voltages are available for the LP 8200. Please contact a Tektronix Sales Office in your area for more information.

4025 Computer Display Terminal

The 4025 Computer Display Terminal is an optional peripheral for use with the 8001 or 8002A Microprocessor Development Labs.

The 4025 Computer Display Terminal is serially interfaced to either Microprocessor Development Lab through an EIA standard RS-232-C port on the systems communications module. The 4025 Terminal provides all the capabilities of the 4024 plus the ability to expand from basic alphanumerics, to forms ruling and then into graphics. Option 20 (8K bytes Program Memory) is required for proper 8001 and 8002A operation.

4025 Computer Display Terminal with Option 20* $4050

*Option 20 (8K bytes Display Memory) is required for proper 8001 and 8002A operation.

MDL WORKSHOP

Tektronix offers four Microcomputer Development Lab Workshops in a number of locations throughout the year. The courses on intensive, hands-on workshops designed to help the attendee meet the demanding challenges of the growing microcomputer development market.

Introduction to Microprocessor Software Design Workshop

The Introduction to Microprocessor Software Design Workshop is a comprehensive look at microcomputer software development, from flowcharting through hardware/software integration. It includes hands-on experience with the 8550 Microprocessor Development Lab, a self-contained microcomputer design tool. The introduction to Microprocessor Software Design Workshop is a Five-day course.

8550 Operations Workshop

The 8550 Operations Workship covers all aspects of the 8550 Microprocessor Development Lab, a design tool used for both software development and hardware/software integration. The 8550's features are explored in depth and applied to a typical microcomputer design cycle. Throughout the course, the attendee gets intensive, hands-on experience for an in-depth understanding of all 8550 operations. The 8550 Operations Workship is a Five-day course.

Microprocessor Hardware/Software Integration Techniques

The Microprocessor Hardware/Software Integration Techniques Workshop examines various aspects of the microcomputer design cycle and the role of each in the overall development scheme. Throughout the course, the participant will work with a number of design tools commonly used in developing microprocessor-based systems. Included are the 8550 MDL, logic analyzers, oscilloscopes and data communications testers. Extensive hands-on experience is provided for each tool. The Microprocessor Hardware/Software Integration Techniques Workshop is a Five-day course.

Microprocessor Software Development with Pascal Workshop

The Microprocessor Software Development With Pascal Workshop is an intensive examination of Pascal and its relationship to microcomputer software development. It emphasizes how to "think" in Pascal program structure and looks at the philosophy behind the language. In addition to defining the language in terms of the ISO Pascal standing, the course introduces Tektronix's special extensions aimed specifically at developing code at the microprocessor level. Also considered are tradeoffs between using assembly or high level language for micro software development, and the process of linking Pascal modules with assembly-written modules to form a complete program. The Microprocessor Software Development with Pascal Workshop is a Five-day course.

For detailed information on Tektronix Microcomputer Development Workshops and Workshop schedules, contact your local Tektronix Sales Engineer.

Ordering Information and Matrix

8001 Microprocessor Lab — $5350

Field Number	Emulator Support:	Factory Configuration Number	Price
8001F01	8080A Microprocessor Support Package	Option 01	$4100
8001F02	6800 Microprocessor Support Package	Option 02	$4100
8001F2A	6802 Prototype Control Probe	Option 2A	$ 990
8001F2B	6802 Microprocessor Support Package	Option 2B	$4100
8001F03	Z80A Microprocessor Support Package	Option 03	$4100
8001F04	TMS9900 Microprocessor Support Package	Option 04	$5100
8001F05	8085A Microprocessor Support Package	Option 05	$4100
8001F06	3870/3872 Microprocessor Support Package	Option 06	$4900
8001F07	F8 Microprocessor Support Package	Option 07	$4600
8001F08	1802 Microprocessor Support Package	Option 08	$4900
8001F09	8048/8021 Microprocessor Support Package	Option 09	$3710
8001F10	8048 Prototype Control Probe	Option 10	$1190
8001F11	8021 Prototype Control Probe Adapter (requires 8001F09 & 8001F10)	Option 11	$ 350
8001F12	8041A Prototype Control Probe (requires 8001F09)	Option 12	$1190
8001F13	8022 Prototype Control Probe (requires 8001F09)	Option 13	$1190
8001F14	6500/1 Microprocessor Support Package	Option 14	$4100
	System Options:		
——	32K Program Memory Modules	Option 45	$3100
8001F46	Real-Time Prototype Analyzer	Option 46	$2700
8001F48	2704/2708 PROM Programmer	Option 48	$ 650
8001F49	16K Program Memory Module	Option 49	$1550
——	220 V at 50 Hz	Option 4W	NC

8550 Microcomputer Development Lab — $12750

	Assemblers:		
8300A01	8080A/8085A Assembler	Option 1A	$ 850
8300A02	6800/6801/6802 Assembler	Option 1B	$ 850
8300A04	Z80A Assembler	Option 1C	$ 850
8300A05	TMS9900 Assembler	Option 1D	$ 950
8300O07	3870/3872/F8 Assembler	Option 1E	$ 850
8300A09	1802 Assembler	Option 1F	$ 850
8300A10	8048/8021/8041A/8022 Assembler	Option 1G	$ 850
8300A14	6500/1 Assembler	Option 1H	$ 850
8300A15	8086/8088 Assembler	Option 1J	$ 950
8300A20	Z8000 Assembler	Option 1K	$ 950
8300A26	68000 Assembler	Option 1L	$ 950
	Emulators:		
8300E01	8080A Emulator Processor and Emulator Control Software	Option 2A	$2350
8300E02	6800/6802 Emulator Processor and Emulator Control Software	Option 2B	$2350
8300E04	Z80A Emulator Processor and Emulator Control Software	Option 2C	$2350
8300E05	TMS9900 Emulator Processor and Emulator Control Software	Option 2D	$3150
8300E06	8085A Emulator Processor and Emulator Control Software	Option 2E	$2350
8300E07	3870/3872/F8 Emulator Processor and Emulator Control Software	Option 2F	$3150
8300E09	1802 Emulator Processor and Emulator Control Software	Option 2G	$3150
8300E10	8048/8021/8041A/8022 Emulator Processor and Emulator Control Software (requires 8300P10, 8300P12, or 8300P13)	Option 2H	$2950
8300E14	6500/1 Emulator Processor, Prototype Control Probe, and Emulator Control Software	Option 2J	$3340
	Probes:		
8300P01	8080A Prototype Control Probe	Option 3A	$ 990
8300P02	6800 Prototype Control Probe	Option 3B	$ 990
8300P03	6802 Prototype Control Probe	Option 3C	$ 990
8300P04	Z80A Prototype Control Probe	Option 3D	$ 990
8300P05	TMS9900 Prototype Control Probe	Option 3E	$1160
8300P06	8085A Prototype Control Probe	Option 3F	$ 990
8300P07	3870/3872 Prototype Control Probe	Option 3G	$ 990
8300P08	F8 Prototype Control Probe	Option 3H	$ 990
8300P09	1802 Prototype Control Probe	Option 3J	$ 990
8300P10	8048 Prototype Control Probe	Option 3K	$1190
8300P11	8021 Adapter (requires 8300P10)	Option 3L	$ 350
8300P12	8041A Prototype Control Probe	Option 3M	$1190
8300P13	8022 Prototype Control Probe	Option 3N	$1190
	Language Products:		
8300G01	Pascal 8080/8085	Option 1P	$1950
8300H01	Modular Development Language; 8080/8085/Z80	Option 1Q	$1000
8300H02	Modular Development Language; 6800/6802	Option 1R	$1000
	Prototype Debug Package:		
8300D15	8086 Prototype Debug Support	Option 2S	$1650
	System Options:		
8550F01	Real Time Prototype Analyzer	Option 01	$2700
8550F02	32K Static Memory Board	Option 02	$3100
8550	Universal Euro 220V/16A Power	Option A1	NC
8550	U.K. 240V/13A Power	Option A2	NC
8550	Australia 240V/10A Power	Option A3	NC
8550	North American 240V/15A Power	Option A4	NC
8550	115V at 50 Hz	Option 4X	NC
8550	230V at 50 Hz	Option 4Y	NC

	Peripherals	
LP8200	Line Printer Option 4W 220 V at 50 Hz	$3765
4024	Computer Display Terminal with Option 20*	$3450
4025	Computer Display Terminal with Option 20*	$4050
	*Option 20 (8K bytes Display Memory) is required for proper 8001/8002A operation	
	Accessories	
RS232	Interconnecting cable 012-0757-00 (10 feet — 300 cm)	$ 100
Null-Modem	Interconnecting cable 012-0820-00 (5 feet — 150 cm)	$ 80

*Order the products as 8001 or 8550 options to have the system factory configured and tested.

8002A Microprocessor Lab (includes 32K Program Memory) — $10,950

Field Number		Factory Configuration Number*	Price
8002F01	8080A Assembler Software Support	Option 01	+$ 850
8002F1A	MDL/8080A/8085A Software Support (requires 64K Program Memory & Option 01 or 05)	Option 1A	+$1000
8002F02	6800 Assembler Software Support	Option 02	+$ 850
8002F2A	MDL/6800 Software Support (requires 64K Program Memory & Option 02)	Option 2A	+$1000
8002F03	Z80A Assembler Software Support	Option 03	+$ 850
8002F3A	MDL/8080A/Z80A Software Support (requires 64K Program Memory & Option 03)	Option 3A	+$1000
8002F04	TMS9900 Assembler Software Support	Option 04	+$ 850
8002F05	8085A Assembler Software Support	Option 05	+$ 850
8002F06	F8/3870/3872 Assembler Software Support	Option 06	+$ 850
8002F07	1802 Assembler Software Support	Option 07	+$ 850
8002F08	8048/8021 Assembler Software Support	Option 08	+$ 850
8002F09	6500/1 Assembler	Option 09	+$ 850
8002F13	8086/8088 Assembler	Option 13	+$ 950
8002F14	Z8000 Assembler	Option 14	+$ 950
8002F15	68000 Assembler	Option 15	+$ 950
8002F16	8080A Emulator Support	Option 16	+$2350
8002F17	6800 Emulator Support	Option 17	+$2350
8002F18	Z80A Emulator Support	Option 18	+$2350
8002F19	TMS9900 Emulator Support	Option 19	+$2600
8002F20	8085A Emulator Support	Option 20	+$2350
8002F21	F8/3870/3872 Emulator Support	Option 21	+$2850
8002F22	1802 Emulator Support	Option 22	+$2850
8002F23	8048/8021 Emulator Support	Option 23	+$2350
8002F24	6500/1 Emulator Support (Includes Probe)	Option 24	+$3340
8002F28	8086 Prototype Debug Support	Option 28	+$1650
8002F29	Z8000 Prototype Debug Support	Option 29	+$1650
8002F30	68000 Prototype Debug Support	Option 30	+$1650
8002F31	8080A Prototype Control Probe	Option 31	+$ 990
8002F32	6800 Prototype Control Probe	Option 32	+$ 990
8002F33	Z80A Prototype Control Probe	Option 33	+$ 990
8002F34	TMS9900 Prototype Control Probe	Option 34	+$1160
8002F35	8085A Prototype Control Probe	Option 35	+$ 990
8002F36	3870/3872 Prototype Control Probe	Option 36	+$ 990
8002F37	F8 Prototype Control Probe	Option 37	+$ 990
8002F38	1802 Prototype Control Probe	Option 38	+$ 990
8002F39	6802 Prototype Control Probe	Option 39	+$ 990
8002F40	8048 Prototype Control Probe	Option 40	+$1190
8002F41	8021 Prototype Control Probe Adapter (requires Option 40)	Option 41	+$ 350
8002F42	8041A Prototype Control Probe	Option 42	+$1190
8002F43	8022 Prototype Control Probe	Option 43	+$1190
	32K Program Memory Modules	Option 45	+$3100
8002F46	Real-Time Prototype Analyzer	Option 46	+$2700
8002F48	2704/2708 PROM Programmer	Option 48	+$ 650
8002F49	16K Program Memory Module	Option 49	+$1550

ORDER MATRIX
8002A

Processor	Assembler	Emulator	Probe	HLL	Prototype Debug
8080	Option 01	Option 16	Option 31	Option 1A	
8085	Option 05	Option 20	Option 35	Option 1A	
Z80	Option 03	Option 18	Option 33	Option 3A	
6800	Option 02	Option 17	Option 32	Option 2A	
6802/08	Option 02	Option 17	Option 39	Option 2A	
TMS9900	Option 04	Option 19	Option 34		
3870/72/74/76	Option 06	Option 21	Option 36		
F8	Option 06	Option 21	Option 37		
1802	Option 07	Option 22	Option 38		
8048/8035/8039-6	Option 08	Option 23	Option 40		
8021	Option 08	Option 23	Option 41*		
8041A	Option 08	Option 23	Option 42		
8022	Option 08	Option 23	Option 43		
6500/1	Option 09	Option 24**			
8086	Option 13				Option 28
Z8000	Option 14				Option 29
68000	Option 15				Option 30

*Requires Option 40 **Includes Probe

ORDER MATRIX

To use the matrix below:

A) Identify the mainframe (8001 or 8550).
B) Select a processor (8080, 8085, Z80, 6800, etc.).
C) Select a level of support (assembler, emulator, probe, HLL, Prototype Debug).
D) Order mainframe and options for deemed level of support.*

	8001		8550			
Processor	Emulator Probe	Assembler	Emulator	Probe	HLL	Prototype Debug
8080	Option 01	Option 1A	Option 2A	Option 3A	Option 1P	
8085	Option 05	Option 1A	Option 2E	Option 3F	Option 1Q	
Z80	Option 03	Option 1C	Option 2C	Option 3D	Option 1P	
6800	Option 02	Option 1B	Option 2B	Option 3B	Option 1Q	
6802/08	Option 2B	Option 1B	Option 2B	Option 3C	Option 1P	
TMS9900	Option 04	Option 1D	Option 2D	Option 3E	Option 1Q	
3870/72/74/76	Option 06	Option 1E	Option 2F	Option 3G	Option 1R	
F8	Option 07	Option 1E	Option 2F	Option 3H	Option 1R	
1802	Option 08	Option 1F	Option 2G	Option 3J		
8048/8035/8039-6	Option 09	Option 1G	Option 2H	Option 3K		
8021	Option 11[1]	Option 1G	Option 2H	Option 3L[3]		
8041A	Option 12[2]	Option 1G	Option 2H	Option 3M		
8022	Option 13[2]	Option 1G	Option 2H	Option 3N		
6500/1	Option 14	Option 1H	Option 2J[4]			
8086	Not Available	Option 1J				Option 2S
Z8000	Not Available	Option 1K				
68000	Not Available	Option 1L				

[1]Requires Option 09 and 10 [2]Requires Option 10 [3]Requires Option 3K [4]Includes Probe

*NOTE: If this support is to be added to a previously purchased mainframe, use the equivalent product nomenclature, i.e., FIELD NUMBER (**NOT** the factory configuration option number) when placing your order.

Logic Analyzers

7D02
Logic Analyzer

A user-programmable tool for microprocessor-based design

Find even the most remote hardware or software events. Recent technological advances have made microprocessor-based debugging an increasingly complex task. In response, Tektronix introduces the 7D02 Logic Analyzer. An instrument that's easy to use, yet powerful enough to unravel even the most complex problems found in both state and timing applications.

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NEW 7D02

Unprecedented triggering power in both the state and timing modes of data acquisition

Disassembled mnemonics for fast, simplified interpretation of state information

Up to 52 data channels

A unique user language to enhance testing power

Synchronous (External Clock) and asynchronous (Internal Time Base) operation

Configurable to individual processors

The 7D02 Logic Analyzer can acquire up to 52 channels of state information in the synchronous mode, using the clock of the system under test. The basic instrument contains 28 channels, with an expansion option (03) increasing this to 44. A timing option (01) provides 8 additional channels for a total of 52 synchronous channels. Alternatively, the Timing Option provides 8 channels of asynchronous information, using the 7D02's own clock. The state and timing sections can be operated independently, or used as a trigger source for one and other.

All the 7D02's data acquisition resources are under the control of a unique user language, which allows them to be configured according to the needs presented by a particular situation. Through user programming, almost any combination of resources can be employed to construct specific triggers or data qualifiers.

Synchronous resources include four independent word recognizers up to 48 bits each, two universal time/event counters which can interact with each other and may be reset on the fly, and several modes of clock qualification. Asynchronous resources include a word recognizer, and an 8-channel glitch recognizer with an independent memory.

A series of Personality Modules can adapt the 7D02 to the specific characteristics of individual processors, both 8- and 16-bit. Once data is acquired, it can be displayed in the disassembled mnemonics of the processor in use, as well as hex, octal, ASCII and binary formats. Also available will be a general purpose Personality Module which will enable the user to support those microprocessors not specifically supported by the 7D02, or for other general purpose logic analysis tasks.

SPECIFICATIONS

DISPLAY

Type — State Table; Raster Scan — 24 lines x 32 characters per line. Number of Channels Displayed: (Basic 7D02) = 28, Data = 8, Address = 16, Control = 4. Max Number Acquisition: Memory Locations Displayed = 19.

Radices Available — Data: Mnemonic disassembly for each supported microprocessor. ASCII, Hex, Binary, Octal. Address: Hex, Binary, Octal, ASCII. Control: Mnemonic Disassembly, Binary.

SIGNAL INPUTS

Signal inputs for the 7D02 are obtained through optional Personality Modules. These Personality Modules, along with Option 03, determine the number of channels that will be input to the 7D02.

Basic 7D02 — Data = 8, Address = 16, Control = 6, Ext. Trigger = 1; Total = 31.

Input Impedance — Determined by the Personality Module (PM) used.

SETUP/HOLD TIME

Depends on PM used.

External Trigger — Input Impedance = 1.0M ±2% compatible with a 10X coded probe. Threshold = 1.4 V, Setup Time = 10 ns at BNC, Hold Time = 18 ns at BNC.

Logic Analyzers

CLOCK

Synchronous Only — Minimum time between qualified clocks = 100 ns. Setup/Hold Time — Determined by PM used. Clock Qualifiers; Max Number = 6. 7D02 is capable of shifting or dividing qualified clocks by up to four positions or times respectively.

MEMORY SIZE

Acquisition Memory (Basic 7D02) = 28 x 256.

Storage Memory (Basic 7D02) = 28 x 256.

COUNTERS

2 Universal Counters — Counting Mode: Time Mode; Resolution rates = 1 ms or 1 μs. Accuracy = (±1 count) × (number of start/stop cycles) ±0.01% of value. Maximum count = 65,534. Events Mode: Maximum count = 65,534. Control Mode: Time Mode; Resolution = 1 ms or 1 μs. Minimum interval generated = 2. Maximum interval generated = 65,534. Accuracy of generated interval = (−0/+1 count) × (number of start/stop cycles) ±0.01% of value +(−0 to 0.2 μs). Events Mode: Minimum interval generated = 2. Maximum interval generated = 65,534.

WORD RECOGNIZERS

Number of Word Recognizers = 4. Number of Channels (Basic 7D02) = 32, Data = 8, Address = 16, Control = 6, Ext. Trigger = 1, Timing Option Link = 1 (if timing option installed).

TRIGGERING

The 7D02 can be triggered from any of the Word Recognizers or from either of the Counters, in the Control mode. This gives the 7D02 the ability to track and trigger on very complex program flows.

TRIGGER POSITION

Number of qualified clocks displayed after the trigger point: Trigger Before Data = 240, Trigger Centered = 128, Trigger After Data = 16, Zero Delay = 0.

PROCESSOR HALT

Maximum Number = 4 (the Processor can be halted when the 7D02 stops acquisition). Processor Halt Delay = (2 qualified state clocks after the 7D02 stops acquisition) + PM Delay Time.

DATA QUALIFICATION

Complex data qualification is provided through the use of the Word Recognizers and Counters.

TRIGGER OUT

TTL compatible, capable of driving a 50 Ω unterminated transmission line. Accuracy = 1 qualified clock +86 ns ±35 ns after event occurs at Probe Tip.

MISCELLANEOUS

Size — Three wide 7000 Series Plug-in.

Weight — 3.6 kg (8 lbs).

Power — Line Voltage Ranges — Determined by the 7000 Series Mainframe. Power Consumption — 49 watts at nominal line voltage, includes all options.

Temperature Range — Operating = 0°C to 50°C. Non-Operating = −55°C to +75°C.

Altitude — Operating = 15,000 ft. Non-Operating = 50,000 ft.

OPTION 01 — TIMING OPTION

The Timing Option provides the 7D02 user with 8 additional channels of asynchronous data acquisition at sample rates of up to 50 MHz.

SIGNAL INPUTS

Number of Channels = 8 (using a P6451 Data Probe). Input Impedance = 1 MΩ shunted by approximately 5 pF.

Logic Swing — Minimum = 500 mV +2% of threshold voltage centered on threshold voltage. Maximum = −15 V to at least threshold voltage +10 V. Maximum Non-Destruct Input Voltage = −40 V to at least +40 V.

Threshold Voltage — Programmable from −6.35 to +6.35 in 50 mV increments.

Data Setup/Hold Time — Data Setup = 20 ns. Data Hold = 2 ns.

CLOCK

Asynchronous — Sample Rates = 20 ns to 5 ms in a 1-2-5 sequence. Accuracy = ±0.01%.

Synchronous — Maximum Frequency = 10 MHz. Obtained from system under test via the Personality Module.

MEMORY SIZE

Acquisition Memory = 8 x 255. Glitch Memory = 8 x 255.

WORD RECOGNIZERS

One Data Word Recognizer = 8 channels (ANDed together). One Glitch Word Recognizer = 8 channels (ORed together but ANDed with the Data Word Recognizer). External Trigger In.

TRIGGERING

The Timing Option can be triggered from any or all of the following sources: 1. Timing Option Data Word Recognizer; 2. Timing Option Glitch Word Recognizer; 3. Main Section (7D02) Word Recognizers; 4. External Trigger In.

DIGITAL DELAY

Maximum Delay = 65,534 Sample Clocks.

GLITCH LATCH

Minimum Pulse Width = 5 ns. ASYNCHRONOUS Mode Only.

DISPLAY

Timing Diagram Mode — Number of Channels = 8, Window Size = 124 words in X1 mode or 31 words in X4 mode. Data channels can be relocated by the user. Numeric Formats: Hex, Octal, Binary, ASCII. Glitch displayed as a * in the table beside DATA. Glitch Display: Glitches are displayed by an ↓ above the line where the glitch occured. Max Number of Words Displayed = 19. Numeric Formats: Hex, Binary, Octal, ASCII. Number of Words Scrolled = 255. Trigger Position Accuracy = ±1 bit (ASYNCHRONOUS Mode).

MISCELLANEOUS

The Timing Option comes standard with a P6451 Data Acquisition Probe.

OPTION 03 — EXPANSION OPTION

The Expansion Option provides the 7D02 with the ability to support most 16-bit microprocessors.

SIGNAL INPUTS

Adds an additional 16 bits to the 7D02. Data = 8; Address = 8.

WORD RECOGNITION

Maximum Number of Channels = 48, Data = 16, Address = 24, Control = 6, Ext. Trigger = 1, Timing of Line = 1 (if timing option installed).

DISPLAY

Maximum Number of Channels = 44, Data = 16, Address = 24, Control = 4.

MEMORY SIZE

Acquisition Memory = 44 x 256. Storage Memory = 44 x 256.

ORDERING INFORMATION

7D02 Logic Analyzer $3975

Option 01 (timing) . . . . . Add $1600
Option 7D02F01 (timing, field-installed) $1850
Option 03 (expansion) . . . . . Add $1000
Option 7D02F03 (expansion, field-installed) $1200

OPTIONAL ACCESSORIES

016-0669-00 — (fits any 7600 or 7400 mainframe) Hardware kit, Electrical equipment: Logic Analyzer securing **$10**
067-0939-00 — Service Maintenance Kit **$450**

All test parameters supplied by prompts.

IF clause defines a data stream event, which may be either single or compound.

THEN clause defines a response to the event. In this case, setting counter #1 to zero and then incrementing every millisecond.

At the same time the counter is set, branch to the second test (bracketing allows simultaneous actions).

```
 TEST 1
1IF
1  WORD RECOGNIZER # 1
1  DATA=XX
1  ADDRESS=B000
1  /NMI=X /IRQ=X FETCH=X R/W=X
1  BA=X INVAL OP=X  EXT TRIG IN=X
1  TIMING WR=X
1THEN DO
1
1  COUNTER # 1 2-MS
1     2-RESET AND RUN
1  GOTO 2
1
 END TEST 1
 TEST 2
2IF
2  WORD RECOGNIZER # 2
2  DATA=XX
2  ADDRESS=F820
2  /NMI=X /IRQ=X FETCH=X R/W=X
  DISPLAY ← PROGRAM
```

By using the proper personality module, software flow can be displayed using the mnemonics of the chip under test, here the Motorola MC6802.

```
 CTR1=00100 MS  . TRIG LOC = 015
 CTR2=00000 EVT . TRIG IN TEST 2
LOC    ADDRESS OPERATION /IRQ/NMI
010      F834    BNE     $F82C   11
011      F835     F6 READ        11
012      F82C    INC     $0006   11
013      F82D     00 READ        11
014      F82E     06 READ        11
015T     0006     02 READ        11
016      0006     03 WRITE       11
017      F82F    BEQ     $F865   11
018      F830     34 READ        11
019      F831    TST     $0004   11
020      F832     00 READ        11
021      F833     04 READ        11
022      0004     0F READ        11
023      F834    BNE     $F82C   11
024      F835     F6 READ        11
025      F82C    INC     $0005   11
026      F82D     00 READ        11
  DISPLAY ← ACONEM 0-MAIN
     1-MNEMONIC
      0 ABSOLUTE
      1 MNEMONIC
```

The 7D02 now monitors the data stream for an event to satisfy the second test's IF clause.

If the event occurs, then activate the trigger.

Or if counter #1 has reached 100 mS, then branch back to the first test and start the program over.

```
 END TEST 1
 TEST 2
2IF
2  WORD RECOGNIZER # 2
2  DATA=XX
2  ADDRESS=F820
2  /NMI=X /IRQ=X FETCH=X R/W=X
2  BA=X INVAL OP=X  EXT TRIG IN=X
2  TIMING WR=X
2THEN DO
2  GOTO 1
2OR IF
2  COUNTER # 1 = 00100 2-MS
2THEN DO
2  TRIGGER 0-MAIN
2       0-BEFORE DATA
2       0-SYSTEM UNDER TEST CONT.
2       0-STANDARD CLOCK QUAL.
 END TEST 2
  DISPLAY ← PROGRAM
```

Personality Modules for Logic Analyzers

PM 101
General Purpose Personality Module

Data Acquisition and display formatting for any type of 8- or 16-bit microprocessor.

The PM 101 Personality Module offers data acquisition capabilities designed to fit any type of synchronous digital system including those with 8- or 16-bit microprocessors. The module attaches to the TEKTRONIX 7D02 Logic Analyzer*, and provides a total of 24 address lines, 16 data lines, and 10 control lines, 6 of which may be used as clock qualifiers. It also provides an external Halt interrupt line which may be used by the logic analyzer to interact with the system under test.

With the PM 101, data is acquired synchronously, stored in logic analyzer memory, then formatted for hexadecimal, octal, binary, or ASCII display. All formatting logic is supplied by the PM 101.

*To use all 50 input lines offered by this module, the 7D02 Logic Analyzer must have Option 03 Expansion.

SIGNAL INPUTS

Maximum number of channels = 50, Data = 16, Address = 24, Control = 10. Input Impedance: ½ LSTTL load shunted by 25 pF nominal.

Input-Voltage Limits:	**Min**	**Max.**
Low	0	0.5 V
High	2.4	7.0 V

Input-Current Limits:

Low (V_{in} low = 0.4 V)	−0.2 mA max
High (V_{in} high = 7.0 V)	+0.1 mA max
High (V_{in} high = 2.7 V)	+0.02 mA nominal

Maximum Input Voltage, Non-Operating, Non-Destructive: −7 V to +15 V. Limited to two inputs simultaneously on negative voltages. Threshold Voltage: Fixed 1.4 V with 0.4 V hysteresis nominal. TTL compatible.

CLOCK

Input Impedance: 50 kΩ nominal shunted by 15 pF nominal. Maximum Frequency: 10 MHz (100 ns min). Minimum Pulse Width: 25 ns.

SETUP/HOLD TIMES

Clock/Qualifier Inputs: Setup = 55 ns max. 35 ns typical. Hold = 0 ns max. Address and Data Inputs: Setup = 45 ns max. 25 ns nominal. Hold = 0 ns max.

DISPLAY

Maximum number of channels displayed: Basic 7D02 = 28, Data = 8, Address = 16, Control = 4. 7D02 with Expansion Option (Option 03) = 44, Data = 16, Address = 24, Control = 4.

PROCESSOR HALT

Delay = 2 qualified clocks +58 ns nominal after event occurs at probe tip.

MISCELLANEOUS

Size: 12 cm wide x 20.3 cm long x 4.7 cm high (4.7 x 8 x 1.7 inches).

Weight: Approx. 1 kg (2 lbs.) with cables.

Cable Length: From 7D02 to PM pod = 122 ±2.5 cm (4 ft ±1 in).

Operating Temperature: −15 to +55°C

Operating Altitude: 4.5 km (15,000 ft).

ORDERING INFORMATION

PM 101 General Purpose Personality Module $1200
PM 102 6800 Personality Module $1200
PM 103 6802 Personality Module $1200
PM 104 8085 Personality Module $1200

PM 102, PM 103
6800, 6802 Personality Modules

Personalized data acquisition, with built-in display formatting and mnemonic disassembly.

The PM 102 and PM 103 Personality Modules are high-performance data acquisition modules designed for use with 6800 and 6802 microprocessor families, respectively. They attach easily to the TEKTRONIX 7D02 Logic Analyzer and provide a single-plug interface to the microprocessor system under test. The modules acquire and buffer data, transfer it to the logic-analyzer memory, then provide format and disassembly parameters necessary for logic-analyzer display. Both operate synchronously with the microprocessor clock acquiring 8 data lines, 16 address lines, and 9 control lines. They also generate two lines not available with 6800 or 6802 microprocessors: Instruction Fetch and Illegal Op Code.

These Personality Modules are compatible with the following microprocessors:

PM 102	**PM 103**
6800	6802
68A00	68A02
68B00	6808

SIGNAL INPUTS

Maximum number of channels = 33. Data = 8, Address = 16, Control = 9. Input Impedance: ½ LSTTL load shunted by 40 pF nominal.

Input-Voltage Limits:

	Min.	**Max.**
Low	0	0.6 V
High	2.0	7.0 V

Input-Current Limits:

Low (V_{in} low = 0.4 V)	−0.2 mA max
High (V_{in} high = 7.0 V)	+0.1 mA max
High (V_{in} high = 2.7 V)	+0.02 mA nominal

Maximum Input Voltage, Non-Operating, Non-Destructive: ±15 V continuous on any two imputs simultaneously. Threshold Voltage: Fixed 1.4 V with 0.4 V hysteresis nominal. TTL compatible.

CLOCK

Input Impedance: 50 kΩ nominal shunted by 35 pF nominal. Maximum Frequency: 2 MHz PM 102 (6800); 6 MHz PM 103 (6802). Clock Pulse Width PM 102: Low = 180 ns min. High = 180 ns min.

SETUP/HOLD TIMES

Data Inputs: Setup = 40 ns max. Hold = 0 ns max.

DISPLAY

Maximum number of channels displayed: Data = 8, Address = 16, Control = 4. Read/Write, NMI, IRQ, FETCH

PROCESSOR HALT

Delay = 2 qualified state clock +90 ns nominal after the 7D02 stops acquisition.

MISCELLANEOUS

Size: 12 cm wide x 20.3 cm long x 4.3 cm in height (4.7 x 8 x 1.7 inches).

Weight: Approx. 1 kg (2 lbs) with cables.

Cable Length: From 7D02 to PM pod = 122 ±2.5 cm (4 ft ±1 in). From PM pod to replacement plug = 33 ±1.2 cm (13 ± ½ in).

Operating Temperature: −15 to +55°C.

Operating Altitude: 4.5 km (15,000 ft).

PM 104 8085 Personality Module

Specially designed for 8085 system analysis, with built-in display formatting and mnemonic disassembly.

The PM 104 Personality Module is a dedicated acquisition module designed for use on 8085 microprocessor-based systems. When used with the TEKTRONIX 7D02 Logic Analyzer, this module allows personalized acquisition of the microprocessor's 16 address lines, 8 data lines, and 10 control lines. Data is acquired synchronously from the system under test, loaded into logic-analyzer memory, then formatted and disassembled for logic-analyzer display. With the PM 104, you have a single-plug interface to all 8085, 8085A, and 8085A-2 microprocessor activity.

SIGNAL INPUTS

Maximum number of channels = 34. Data = 8, Address = 16, Control = 10. Input Impedance: ½ LSTTL load shunted by 40 pF or nominal.

Input-Voltage Limits:	**Min.**	**Max.**
Low	0	0.6 V
High	2.0	7.0 V

Input-Current Limits:

Low (V_{in} low = 0.4 V)	−0.2 mA max
High (V_{in} high = 2.7 V)	+0.02 mA nominal

Maximum Input Voltage, Non-Operating, Non-Destructive: −7 to +15 V continuous, limited to 5 inputs pulled high simultaneously. Threshold Voltage: Fixed 1.4 V with 0.4 V hysteresis nominal. TTL compatible.

CLOCK

Input Impedance: 50 kΩ nominal shunted by 40 pF nominal. Clock Pulse Width: Low = 40 ns min. High = 70 ns min. Clock Input to 8085: 10 MHz max.

SETUP/HOLD TIMES

Data and Address Inputs: Setup = 50 ns max. Hold = 0 ns max.

ALE Input: Setup = 40 ns max. Hold = 0 ns max.

HOLD Input: Setup = 120 ns (measured to trailing edge of CLK, T_2, or TWAIT). Hold = 0 ns.

READY Input: Setup = 135 ns max (referenced to rising edge of T_2). Hold = 0 ns.

PROCESSOR HALT

Delay = 2 qualified state clocks +63 ns nominal after the 7D02 stops acquisition.

DISPLAY

Maximum number of channels displayed = 28. Data = 8, Address = 16, Control = 4. Read/Write, IO, M, INRQ (any interrupt request), IFC (fetch).

MISCELLANEOUS

Size: 12 cm wide x 20.3 cm long x 4.3 cm in height (4.7 x 8 x 1.7 inches).

Weight: Approx. 1 kg (2 lbs) with cables.

Cable Length: From 7D02 to PM pod = 122 ±2.5 cm (4 ft ±1 in). From PM pod to replacement plug = 33 ±1.2 cm (13 ± ½ in).

Operating Temperature: −15 to +55°C.

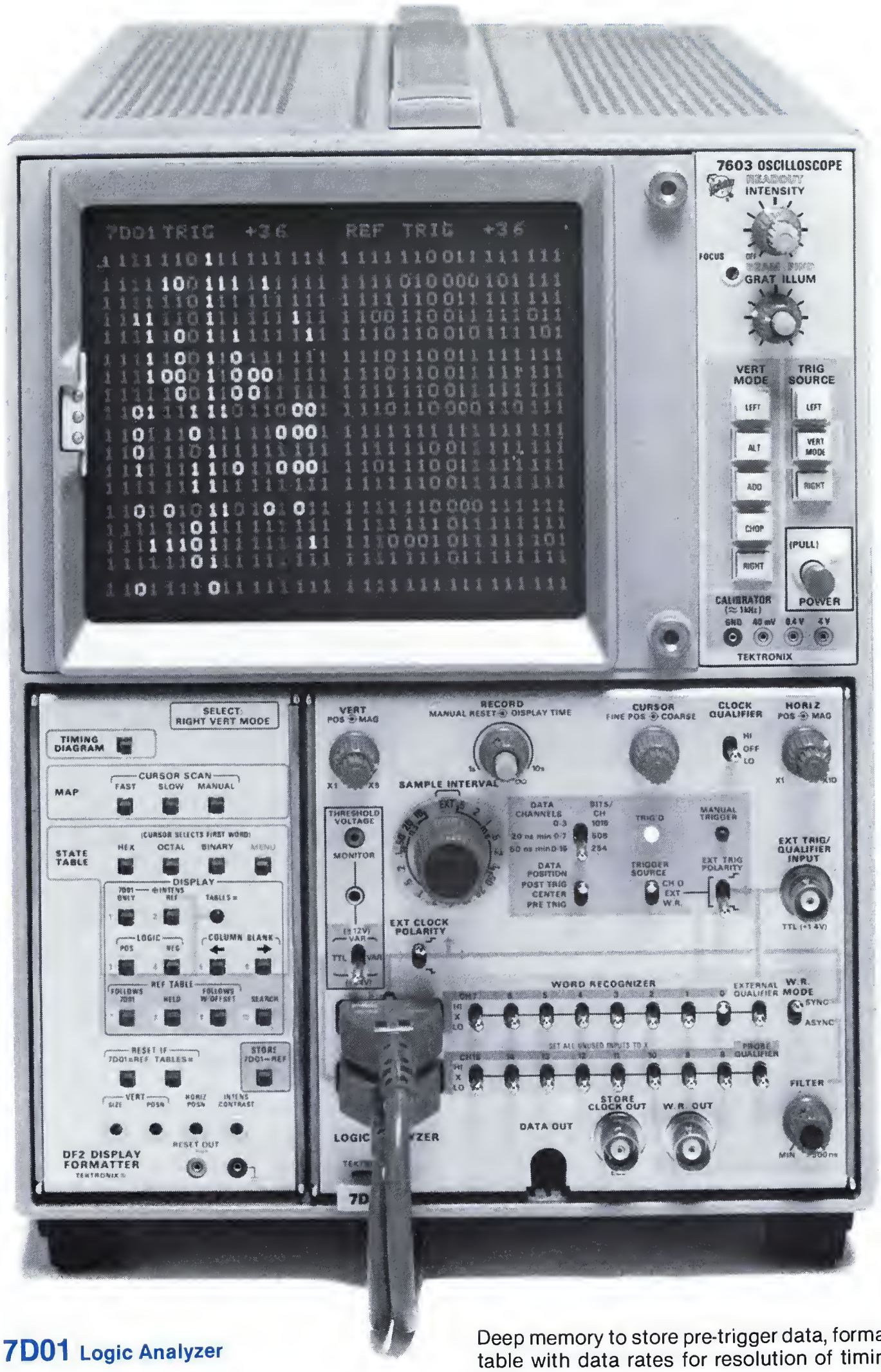
Operating Altitude: 4.5 km (15,000 ft).

Future Microprocessor Support For the 7D02 Logic Analyzer.

It is Tektronix' intent to offer Logic Analysis support, through new personality modules for the 7D02, for the most popular microprocessors used in design.

We will announce our *intent to support* a microprocessor when we have finished a design feasability study and we feel confident in being able to supply you with high quality support. We will therefore *announce support* for microprocessors well in advance of supplying the actual microprocessor personality module. Estimated availability would also be announced at that time.

Logic Analyzers



7D01 Logic Analyzer

The 7D01 Logic Analyzer is a versatile plug-in to a 7000 Series Mainframe that acquires 16 channels of data simultaneously, contains its own 16 bit parallel word recognizer with two qualifiers, features a clock qualifier, and captures single shot data. It has a formattable memory that stores 4096 bits in four, eight or 16 channel formats, features a movable cursor and comes equipped with two high-impedance probes. Plus many other features.

Tektronix 7D01 Logic Analyzers offer:

16 channel Operation to store and monitor signals on up to 16 data lines.

Asynchronous timing resolution to 15 ns.

Deep memory to store pre-trigger data, formattable with data rates for resolution of timing problems:

= Asynchronous:
+16 channels x 254 bits at 20 MHz
+8 channels x 508 bits at 50 MHz
+4 channels x 1016 bits at 100 MHz
= Synchronous:
+ Up to 50 MHz in 4 + 8 channels
25 MHz in 16 channels

High Impedence probes that won't load your circuits.

Word Recognition using 16 channels and two qualifiers.

Pre-set, variable or split thresholds for working with different logic families.

The 7D01 is a dual-wide, plug-in instrument which occupies one vertical amplifier compartment and an adjacent time base compartment in any 7000 Series Oscilloscope Mainframe. With this compatibility, you can configure a total logic analysis system. Using a four-wide mainframe oscilloscope, you can combine your logic analyzer with your analog oscilloscope and display the outputs of both at the same time.

For efficient use of the memory, Tektronix logic analyzers format the memory according to the number of input channels required. You can select 16 channels of 254 bits each at a 20 MHz sampling rate, eight channels of 508 bits each at 50 MHz, or four channels of 1016 bits at 100 MHz, or a synchronous sampling rate of 50 MHz.

Four methods of obtaining a trigger to store and display data are available. First, use the manual trigger button as a trigger source — even if no data has been acquired — so you can center the traces and set intensity levels. Or, you can generate a trigger by the first positive-going transition on data channel 0. Third, trigger (of either polarity) can be received through a front panel BNC jack. Or, a trigger can be generated by a unique data combination using the word recognizer.

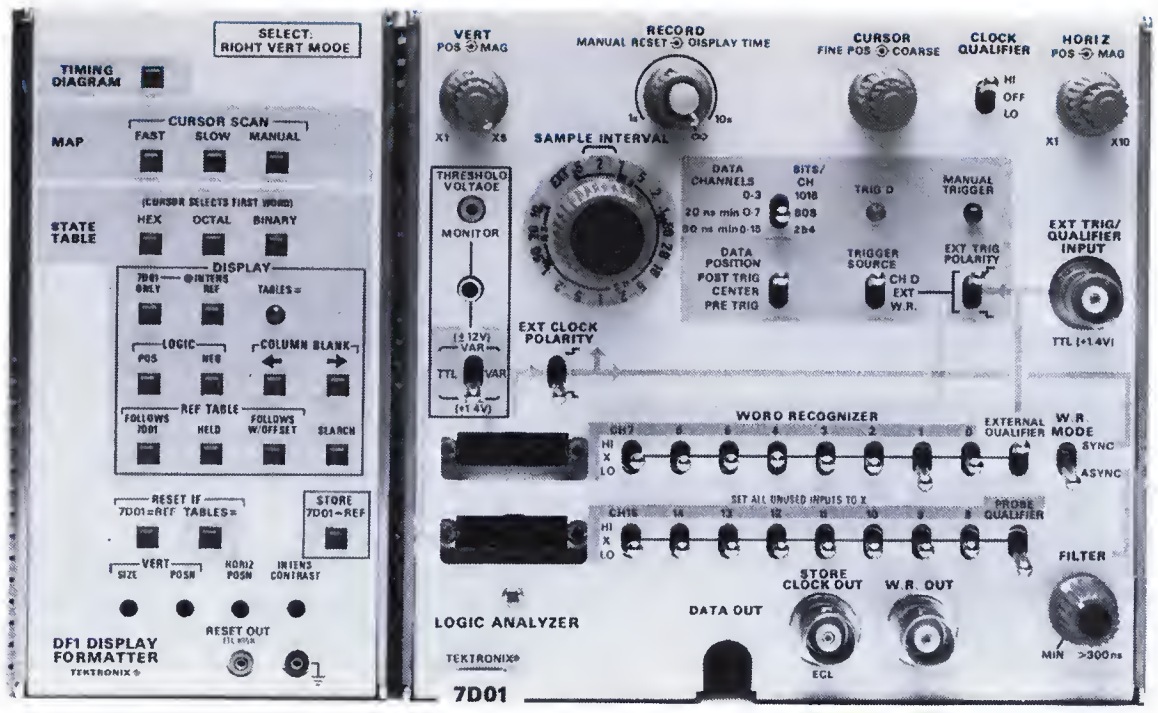
The 7D01 Word Recognizer provides you with an output when the logic states of the input channels match the word recognizer switches that you've chosen. Use the probe qualifier and external qualifier functions to help you select your trigger word. A variable async filter (10 ns to 300 ns) inhibits the word recognizer output to prevent false triggering from glitches or data skew.

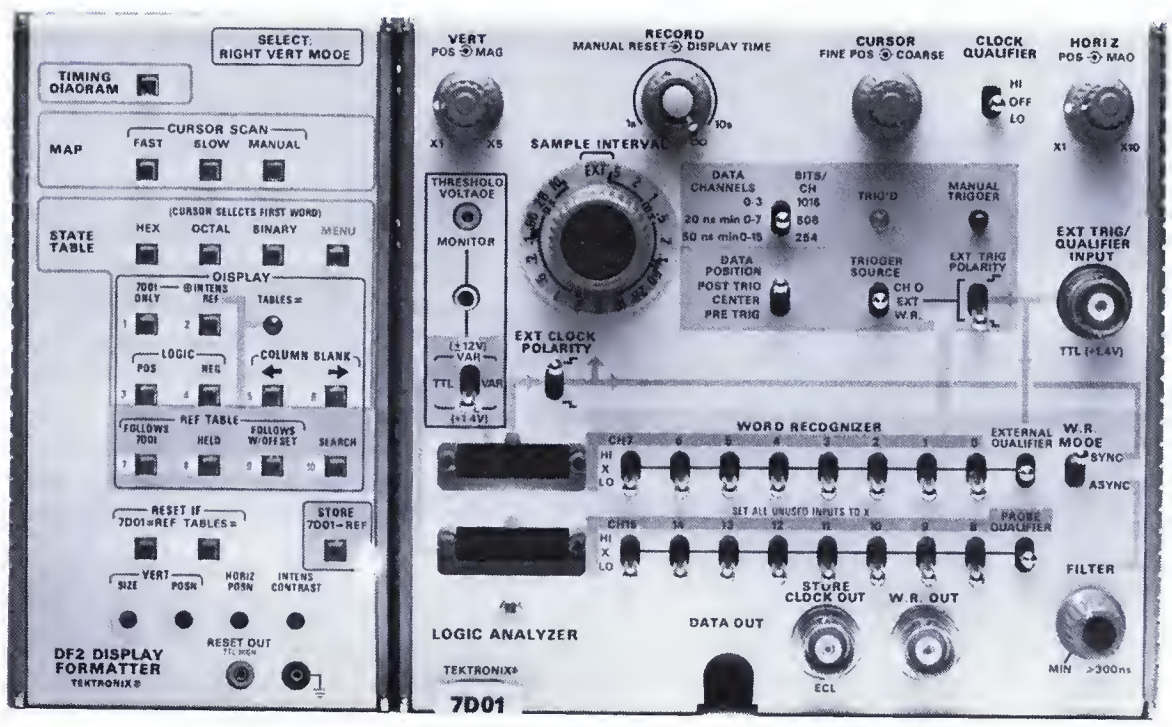
A clock qualifier can be used when the 7D01 is sampling in the synchronous mode, using the clock of the system under test. During normal operation, new data is sampled into memory once during each clock cycle. When the clock qualifier is activated, sampling will occur only when the cycle has been qualified by an external signal.

The 7D01 features pre-, post- or center-trigger displays. The location is displayed with a column of intensified dots, one on each channel. You can position a second column of dots anywhere on the display with a movable cursor, using the FINE position to move it in single increments, or the COARSE position, to move it in increments of 16 sample intervals. An alphanumeric display locates the cursor relative to the trigger. A second display shows the data word at the cursor location, in binary readout.

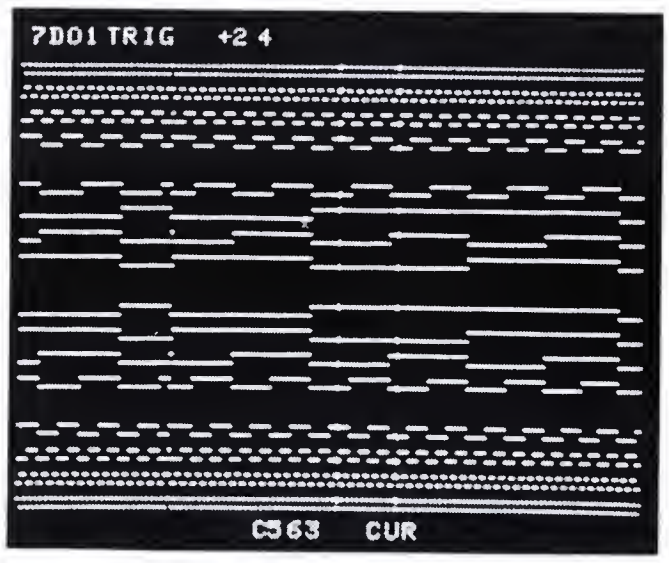
Data is acquired by the 7D01 through two P6451 10-channel, high impedance, active probes. Each probe has eight input channels, an external clock or qualifier channel and a ground lead. Impedance is 1 MΩ paralleled by 5 pF, to minimize loading on test circuits. Grabber tips conveniently clip onto DIP leads, or, by removing the grabber tips, you can connect the leads directly to 25 mil pins. Logic input thresholds can be selected at a pre-set TTL level or at any variable level between ±12 V. Or, you can set one probe to TTL and the other to a varied threshold. To make sure you've selected the proper level, monitor the threshold voltage on the front panel jack.

Display Formatters for Logic Analyzers

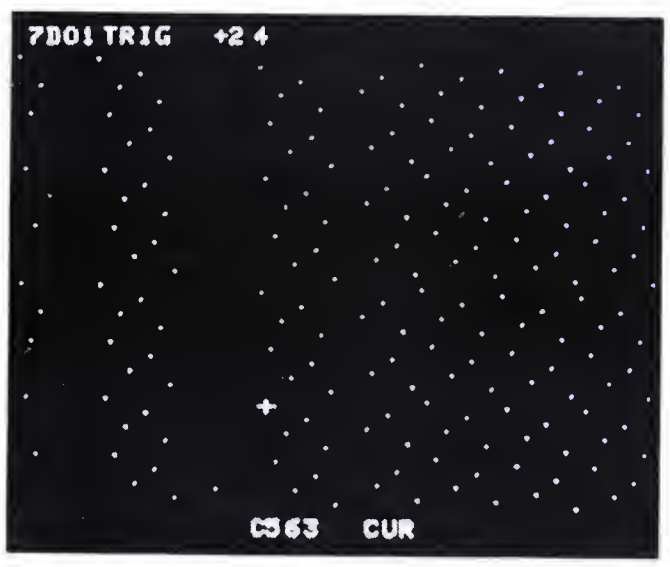




TIMING. The timing diagram formatted by the DF1 and DF2 features cursor word readout in Binary, Hex or Octal.



The DF1 and DF2 display timing data similar to the 7D01 except that state readout can be binary, hex or octal (plus IEEE-488/GPIB and ASCII in the DF2) as desired, and that the mainframe need not be equipped with CRT readout.



Both the DF1 and DF2 display a formatted map with up to 64K unique data word locations (254 can be displayed at one time) in a dot matrix according to value.

Display Formatters

There are two Display Formatters available with the 7D01 Logic Analyzer — the DF1 and DF2. Both offer Timing, Mapping, and State Table Displays in Binary, Hexadecimal and Octal formats. The DF2 offers additional formats for IEEE-488/GPIB and ASCII.

The Display formatters are dedicated for use with the 7D01. It provides complete alphanumeric character generation, so that the logic analysis package can be used in mainframes without CRT readout (mainframe Option 01).

MAPPING. The map mode is used to display data words in memory. Up to 254 words can be displayed at once, in a dot matrix, according to value. The least significant half of the word determines the horizontal position, and the most significant half determines the vertical position. Using the FAST or SLOW modes, a "+" symbol will scan the map data in the same order in which the data was loaded into memory. A state display (in Binary, Hex, or Octal) shows the word at the "+" symbol location. Use the MANUAL mode to the "+" symbol using the cursor control. Cursor location will be displayed at the top of the screen.

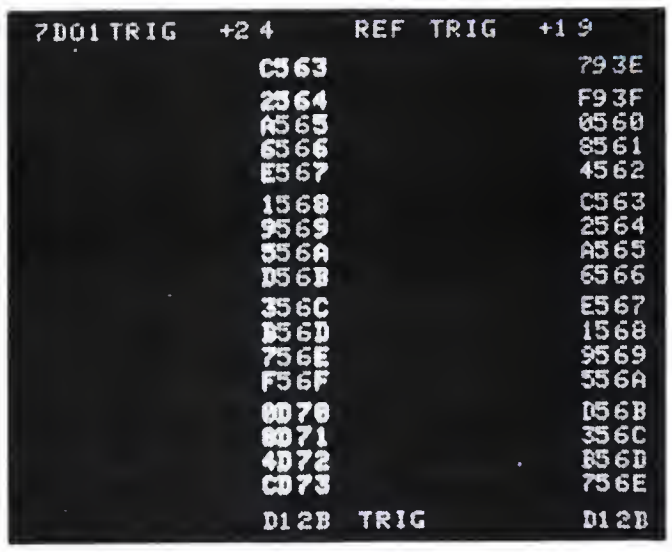
The display map is formatted to match the channel selection of the 7D01. If you choose a 16 Channel display, the map will display up to 64K unique data words, 254 at a time. However, if eight channels are used, the map is reformatted to use the entire display area (a 4-bit by 4-bit matrix). And, if you choose four channel operation, the map is reformatted for full CRT use.

STATE TABLE DISPLAYS

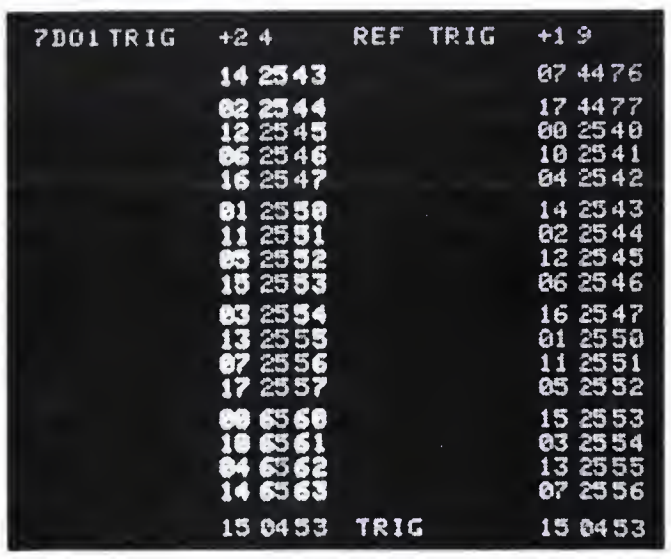
Both the DF1 and DF2 will display state information in Binary, Hexadecimal, or Octal formats, whichever your application requires. The DF2 offers additional formats for IEEE-488/GPIB and ASCII. Each display presents 17 data words. An 18th word, the trigger word, is displayed at the bottom of the CRT, flashing when it occurs on the display.

The portion of the memory which is displayed as a state table is selected by the cursor. Use the cursor to page through all the data stored in memory in various increments, so that you get a total picture of the memory's contents.

BINARY



HEXADECIMAL



OCTAL

Using the 7D01 and DF1 or DF2 package, you can compare newly acquired data with reference data. The EXCLUSIVE OR + feature lets you display stored data on one side of the CRT and newly acquired data from the 7D01 of the other side. You can display one page of memory at a time. Differences in the two fields of data will be highlighted in brightly intensified light. If there are no differences, the TABLE = indicator will light.

There are also two modes of automatic data acquisition in the DF1 and DF2 which compare the entire 7D01 memory to the reference memory. If a difference is detected, the difference and location will be intensified in the display, read out at the top of the CRT, and the number of resets required to find the error will be displayed. This function, called RESET IF 7D01 = REF, allows full comparison of stored and newly acquired data. To compare only the tables selected by the cursor control, use RESET IF TABLES =.

Column blanking gives you the ability to remove unwanted data from state displays. Concentrate your data search by eliminating columns, from left to right, as you find irrelevant data.

Other features which augment the state table displays include "reference table follows 7D01," to compare the reference memory data and new data, a page at a time, automatically. And, "reference table held" lets you move the 7D01 data display and hold the reference table, so you can compare one page in storage to any page of the new data. The amount of offset between the two is indicated by cursor readout. Once the desired offset is acheived, you can hold that offset and continue to sequence through the data, maintaining a constant difference in location.

With the search mode, you can automatically scan the 7D01 memory for a word that you've stored in reference memory. Position the desired word as the first word in the reference state table, press SEARCH, and the DF1 or DF2 will scan the 7D01 memory. When the word is found, it is positioned to the first word in the 7D01 display. Location is also displayed. To repeat this operation, you simply push the SEARCH button again.

The DF2 also includes a GPIB display. This display shows the disassembled instruction in IEEE-488 mnemonics familiar to the GPIB user. A 24 pin GPIB adapter provides the monitoring of the GPIB bus. With this adapter, the DF2 monitors activity on the bus.

Information is acquired synchronously using the data valid (DAV) line as a clock. Up to 254 instructions are stored in the 7D01, disassembled and displayed in format. Up to 18 instructions are displayed at one time. To view all the instructions, scroll the data. The states of four GPIB management lines (ATN, EOI, SRQ, and REN) are displayed in GPIB mnemonics, and eight data lines are displayed in Decimal or Hexadecimal. Four more lines of data are user definable to provide circuit information, and are displayed in Binary. You can monitor and display activity on the data bus, the transfer bus (handshake lines) and the management bus (control lines). You can display timing information with 15 ns resolution.

The DF2 also provides an ASCII display, representing data recorded in the 7D01 memory in all 128 possible ASCII characters. The appropriate ASCII character will be displayed in 8 or 16 channel, along with the Binary, Octal or Hexadecimal value to the right of the character.

DL 502

Digital Latches

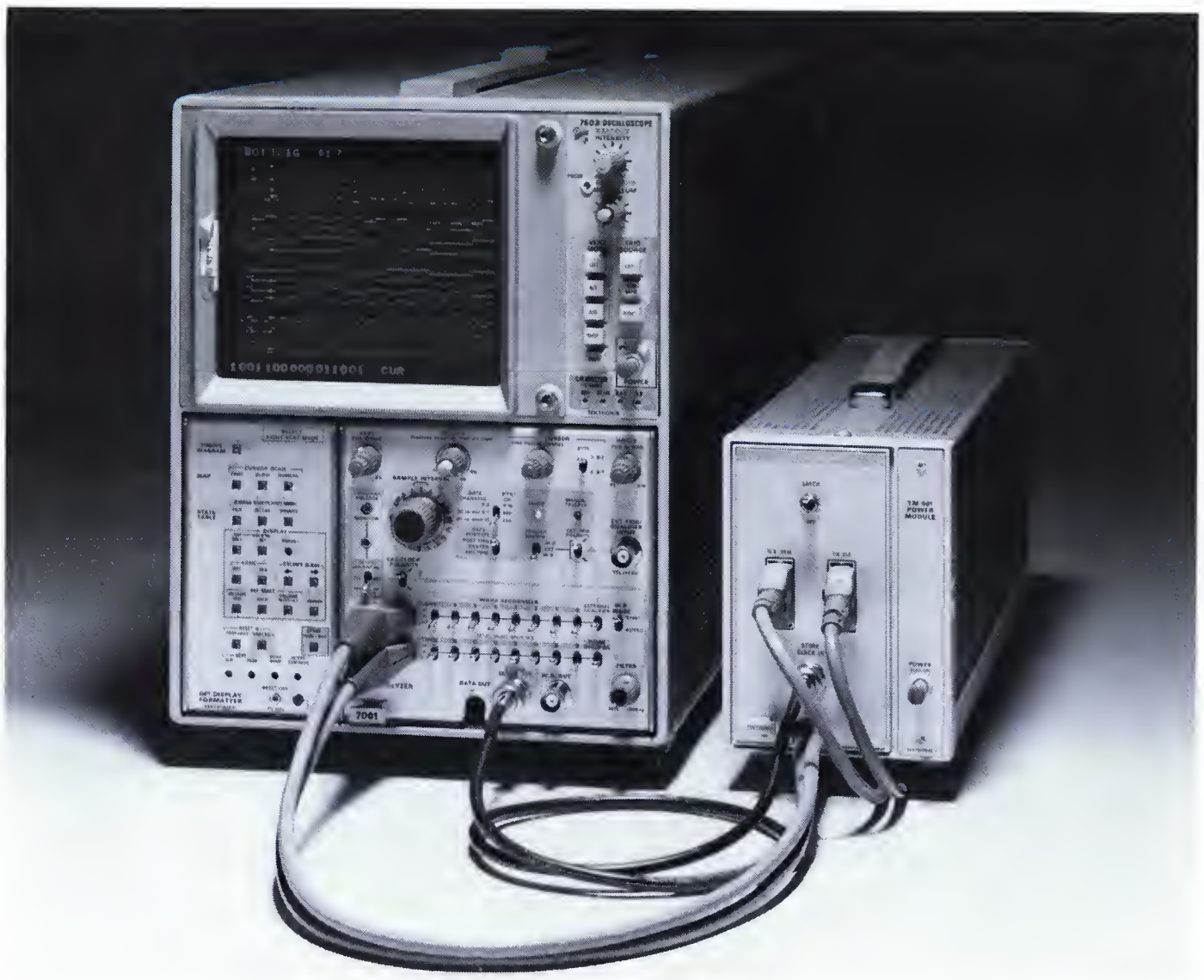
The DL2 and DL 502 Digital Latches extend the 7D01 Logic Analyzer's measurement capabilities by detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. Operating in an asynchronous mode, the 16 channel Digital Latches can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

In asynchronous measurements without latching capability, high speed data anomolies go undetected if they don't appear on a clock edge. With the Digital Latches, you can expand the time frame in which information can be stored by sampling at a slower rate. The captured glitch is held until the next clock edge, and then expanded to one sample interval for display.

The DL2 plugs into any compartment of a 7000 Series Mainframe, along with the 7D01 Logic Analyzer. Data is acquired through P6541 Probes, which plug into the front of the DL2. The DL 502 plugs into any TM 500 Mainframe.

Both formatters offer a two position switch, to select LATCH input mode or OFF. An asynchronous clock input is required from the STORE CLOCK OUT of the 7D01 to the STORE CLOCK IN of the Digital Latch.

Logic Analyzers, Display Formatters, and Digital Latch



The flexibility of the DL 502 allows it to be used in a variety of configurations. It can be used with all TM 500 Mainframes as a companion to the 7D01 Logic Analyzer (as is is depicted above).

Whether you select the 7D01 Logic Analyzer or any of the combinations (7D01F, consisting of the 7D01 and DF1) or the 7D01 and DF2, you can choose any 7000 Series Mainframe for a powerful logic analysis system that is fully compatible with an extensive oscilloscope measurement system. Performance characteristics of the 7D01, DF1, DF2 and DL2 are listed here. Characteristics of the mainframes may be found on pages 83 through 95.

7D01 CHARACTERISTICS

The 7D01 acquires 4, 8, or 16 Ch of data and stores the data in a 4K memory. Data storage format is selectable as 4 Ch x 1016 bits, 8 Ch x 508 bits, or 16 Ch x 254 bits.

Data sampling can be asynchronous (internal clock) or synchronous (external clock). In asynchronous modes, sampling rates can be selected up to 100 MHz in the 4 Ch mode, up to 50 MHz in the 8 Ch mode, or up to 20 MHz in the 16 Ch mode. External sampling clocks up to 50 MHz can be used in the 4 and 8 Ch modes, and up to 25 MHz in the 16 Ch mode.

An invalid light (blinking light behind knob skirt) warns the operator that he has selected:

1. A sampling rate greater than 20 MHz in the 16 Ch mode; or
2. A sampling rate greater than 50 MHz in the 8 Ch mode.

SIGNAL INPUTS

Clock, Qualifier, and Data Input Source — Two multi-lead P6451 Probes provide connections for 10 Ch (9 input and ground) each. Ch 0-7 and clock are through probe 1, and Ch 8-15 and qualifier are through probe 2. Each probe attaches through a 25 pin connector at the 7D01 front panel.

Clock Qualifier —	Setup	Hold
P6451	20 ns	0 ns
*External	11 ns	7 ns

*Measured at external BNC jack. For 0 ns hold time, 42 inch BNC coaxial cable is recommended.

Input Impedance — 1 MΩ paralleled by 5 pF (at probe head).

Threshold at Probe Tips — Front panel switch selects fixed TTL (+1.4 V ±0.2 V), variable (±12 V) or split (variable for top probe, TTL for bottom probe). Front panel jack monitors variable threshold only.

Minimum Logic Swing — 500 mV plus 2% of threshold voltage p-p or less, centered on the threshold voltage.

Maximum Logic Swing — −60 V or less, to at least threshold voltage plus 10 V. (Max non-destructive input ±60 V.)

MEMORY

Storage — 4096 bits.

Format — Front panel selectable.

Data Channels Displayed	Bits per Channel
0-3	1016
0-7	508
0-15	254

SAMPLING RATE

Asynchronous (internal clock) — Sampling intervals are selectable from 10 ns to 5 ms in 18 steps using a 1-2-5 sequence.

Data Channels Displayed	Maximum Sampling Rate	Minimum Sampling Interval*	Min. Data Pluse Width*
0-3	100 MHz	10 ns	15 ns
0-7	50 MHz	20 ns	25 ns
0-15	20 MHz	50 ns	55 ns

*Minimum data pulse width to insure recording is one sample interval +5 ns.

Synchronous (external clock) — + or − edge of clock pulse can be selected to initiate sample.

Data Channels Displayed	Max. Clock Freq.	Minimum Clock Width*	Data Set-up Time Required	Data Hold Time Required
0-3	50 MHz	10 ns	20 ns	0
0-7	50 MHz	10 ns	20 ns	0
0-15	25 MHz	20 ns	23 ns	0

*High and low clock width.

INTERNAL CLOCK

Crystal Oscillator Frequency — 100 MHz ±0.005 MHz.

Sample Intervals — 10 ns to 5 ms/sample in a 1-2-5 sequence.

Store Clock Out Connector — Sampling clock is output during store cycle. This clock may be either the internal or external clock. ECL Level. Reverse terminated in 50 Ω. Do not terminate at receiving end.

WORD RECOGNIZER

Word Recognizer — 16 data inputs, Probe Qualifier and External Qualifier. Output is true when input conditions match settings (HI, X, LO).

Format	Minimum Input Pulse Width (Asynchronous Mode)
Any Single Channel	10 ns or less
Channels 0-3	15 ns or less
Any Other Combination	20 ns or less

Inputs — 16 data input channels plus 2 qualifiers.

Qualifiers — Can be used to recognize 18 bit words.

Word Selection — Made using eighteen 3-position toggle switches. Positions are HI, X (don't care), and LO.

Modes — Synchronous (looks for a match with the selected logic states only at an external clock edge) and asynchronous (looks for a match with the selected logic states at any time).

Synchronous Mode

Characteristic	Time Requirement
Minimum Setup Time	12.5 ns or less
Minimum Hold Time	8.5 ns or less

Async Filter — Rejects recognized words that remain true for less than an operator selected time period. Period is variable from 10 ns to 300 ns.

W.R. Out Connector — A recognized word produces a displayed trigger marker and a front panel output for triggering external circuitry.

Characteristic	Requirement
HI Level	≥1.9 V
LO Level	≤0.1 V
Impedance (Rising Edge)	50 Ω ±10%

TRIGGER

Source — Three-position switch provides selection of trigger source from among channel 0, external (External Trigger/Qualifier Input), or internal word recognizer. A display can also be obtained with front panel MANUAL TRIGGER pushbutton.

Channel 0 — Triggers on rising edge of CH 0 data.

External Trigger/Qualifier Input Connector (EXT TRIG/QUALIFIER INPUT) —

Characteristics	Requirement
Threshold	+1.4 V, ±0.2 V (TTL Level)
Minimum Pulse Width	15 ns
Maximum Safe Input Voltage	−5 V or less, to at least +10 V

Triggered Light — Indicates display trigger has occurred.

Trigger Marker — Trigger position on CRT display is marked by an intensified spot. Spot appears on all displayed channels.

DATA POSITIONING

Three-position switch selects between pre-trigger, center-trigger, and post-trigger modes. In the pretrigger mode ≈90% of the displayed data occurs before the trigger and ≈10% after. In the center-trigger mode ≈50% of the data occurs before the trigger and ≈50% occurs after. In the post-trigger mode ≈10% of the data occurs before the trigger and ≈90% after.

CURSOR

Word Selection — Cursor appears as a movable second intensified spot on the CRT display. It is used to select and mark a word.

Coarse and Fine Position Controls — Coarse control moves cursor in increments of 16 sample intervals. Fine control moves cursor in increments of 1 sample interval.

Cursor to Trigger Position CRT Readout — The difference in sample interval bits between cursor position and trigger position is displayed by the CRT readout at the top, right-hand portion of the CRT graticule (e.g., TRIG ± XXX).

Cursor Position Binary Data — The logic state of each displayed channel coincident with the cursor position is displayed in Binary by the readout at the bottom of the CRT (HI = 1; LO = 0).

Cursor Byte Display — The two-position CURSOR BYTE jumper selects the display format of the cursor readout to either a 3-bit or 4-bit byte. In 16 channel/3-bit byte format, the most significant byte group remains 4 bits.

DISPLAY

Type — Data is displayed as a timing diagram. The number of sample intervals between the trigger and the word selected by the cursor appears as an alphanumeric readout. The word selected by the cursor is displayed as ones and zeros in 3-bit or 4-bit groups.

Display Time — A rotary control is used to select the time for which stored data will be held for display before a new record cycle starts. Variable from less than 1 s to at least 10 s. A detent position provides indefinite storage of data. A new record cycle can be started at any time by pushing the MANUAL RESET button.

Vertical Display Controls (VERT POS/MAG) — A variable vertical magnifier control magnifies the on-screen display from X1 to X5. A concentric vertical position control positions the display within the graticule area.

Horizontal Display Controls (HORIZ POS/MAG) — A variable horizontal magnifier control magnifies the on-screen display from X1 to approximately X10. A concentric horizontal position control positions the display within the graticule area.

Display Format — Selectable by a switch (DATA CHANNELS).

Format	Bits/Chan	Display
Chan 0-3	1016 bits	1 group of 4 traces
Chan 0-7	508 bits	2 groups of 4 traces each
Chan 0-15	254 bits	4 groups of 4 traces each

CRT Retrace Blanking Time —

Format	Bits Blanked
Chan 0-3	8 bits
Chan 0-7	4 bits
Chan 0-15	2 bits

Trigger Intensified Marker — Intensified zone indicating the trigger point, selectable by a switch (DATA POSITION).

Data Position Switch Setting	Intensified Zone Location
Pre-trigger	Near extreme right of display
Center-trigger	Near center of display
Post-trigger	Near extreme left of display

Trigger Intensified Marker Accuracy — Position of intensified zone with respect to word recognizer output.

Sample Interval Control Setting	Maximum Bit Error
10 ns	±4 bits
20 ns	±3 bits
50 ns to 5 ms	±1 bit

DATA OUTPUT

Connector — A 25 pin connector (inside 7D01) provides output of stored data from the 7D01. It also provides control signals necessary for transfer of that data to other equipment. All outputs are ECL levels.

Flag — A positive-going edge on this pin Indicates the end of each channel.

Format — 2 pins are used to identify the stored format as 4 channels x 1016 bits, 8 channels x 508 bits, or 16 channels x 254 bits.

Frame — Occurs every 16th sweep. A positive-going edge indicates end of channel 3. Negative during channel 3.

Display/Store Mode — Store HI
Display LO

Trigger Marker Output — LO = marker point in data stream.

External Display Clock Input — Allows data output at externally selected rates 1 Hz-2 MHz.

POWER

Line Voltage Ranges — Determined by the 7000 Series Oscilloscope Mainframe.

Power Consumption — 32 W at nominal line voltage.

ENVIRONMENTAL

Temperature — Operating: 0°C to +40°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: to 15,000 feet. Nonoperating: to 50,000 feet.

Vibration — With the 7D01 and DF1 or DF2 combined, frequency swept from 10 to 50 cps at one minute per sweep. Vibrate for 15 minutes along each of the 3 major axes at 0.015 inch total displacement. Hold 3 minutes at any major resonance, or if none, at 50 cps. Total time, 54 minutes.

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 s duration, 2 shocks in each direction along 3 major axes, for a total of 12 shocks.

INCLUDED ACCESSORIES

Two, P6451 Data Input Probes (010-6451-03).

DF1 CHARACTERISTICS

The DF1 reformats the output of the 7D01 in a choice of five display formats including Timing, Mapping and state table displays in Binary, Hexadecimal and Octal. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

DF2 CHARACTERISTICS

The DF2 reformats the output of the 7D01 in a choice of seven display formats including Timing, Mapping and state table displays in Binary, Hexadecimal, Octal, ASCII and IEEE-488/GPIB. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

INCLUDED ACCESSORIES

GPIB Probe Adapter for the P6451 (103-0209-00). (A 24 pin IEEE Standard Connector with quick connection to the P6451 Probe Head.)

DL2 CHARACTERISTICS

The 16 channel DL2 aids the 7D01 measurement capabilities by detecting narrow asynchronous pulses of less than one sample interval or as narrow as 5 ns in a data stream. The DL2 plugs into any compartment of a 7000 Series Mainframe. Two 25 pin connectors connect the DL2 with the 7D01. Data is acquired via two P6451 Probes which plug into the front panel of the DL2.

Minimum pulse width to initiate latch — 5 ns.

Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock — 50 ns.

DL 502 Digital Latch

The TEKTRONIX DL 502 Digital Latch extends the logic analyzer's measurement capabilities. The Digital Latch aids in detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. Operating in an asynchronous mode, the 16 channel Digital Latch can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

In asynchronous measurements without latching capability, high-speed data anomalies go undetected if they do not appear on a clock edge. The DL 502 Digital Latch allows you to expand the time frame in which information can be stored by sampling at a slower rate. The DL 502 captures the glitch (or pulses which are narrower than one sample interval) holds it until the next clock edge, then expands it to one sample interval for display.

The DL 502 plugs into any compartment of a TM 500 Mainframe. Two 25 pin connectors connect the DL 502 with the 7D01 Logic Analyzer. Data is acquired via P6451 Probes which plug into the front panel of the DL 502.

A two-position switch allows the user to select either the LATCH input mode or OFF. An asynchronous clock input is required from the STORE CLOCK OUT of the 7D01 Logic Analyzer to the STORE CLOCK IN of the DL 502.

SPECIFICATIONS

Minimum pulse width to initiate latch — 5 ns.

Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock — 50 ns.

ORDERING INFORMATION

7D01F1 Logic Analyzer **$5100**
7D01F2 Logic Analyzer (7D01 and DF2 Display Formatter) **$5700**
7D01 Logic Analyzer **$3770**
DF1 Display Formatter **$1530**
DF2 Display Formatter **$2140**
DL2 Digital Latch **$1650**
DL 502 Digital Latch **$1480**
7603 Oscilloscope* **$2555**
Option 01 (Deletes one readout board) . . . . . **Sub $300**
7704A Oscilloscope* **$4220**
Option 01 (Deletes one readout board) . . . . . **Sub $300**

To modify your present 7D01 to include the new clock qualifier feature order Clock Qualifier* modification kit.

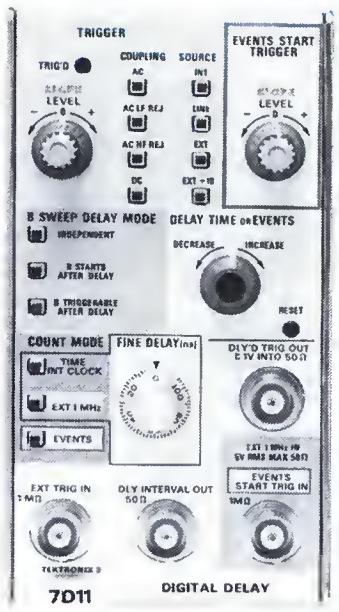
040-0891-00 . . . . . **$70****

*See pages 83 through 110 in this catalog for details on these and additional 7000 Series Mainframes. See pages 111 through 132 for details on complementary 7000 Series Plug-ins.

**Price does not include installation.

Tektronix offers maintenance training classes on Logic Analyzers and a new multi-media training package on Logic Analyzer Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

Logic Analyzer Companion Instruments



7D11 Delay Counter

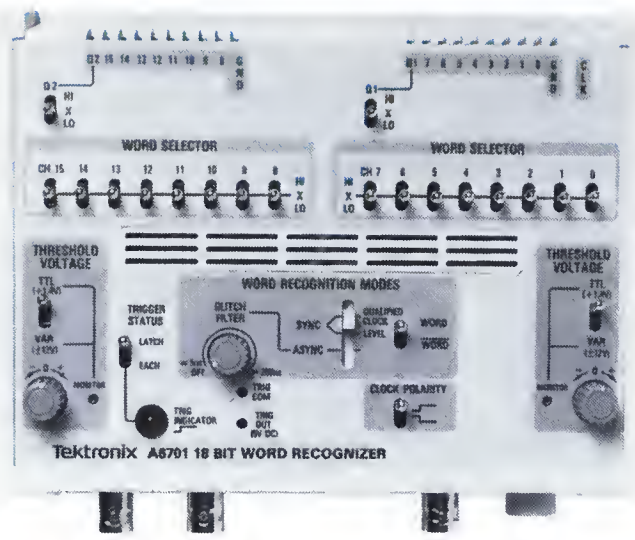
The 7D11 lets you add delay to your 7D01 Logic Analyzer trigger. The 7D11 delays by time as well as digital events. Both units provide a trigger pulse output upon counting a pre-selected number of digital pulses.

For example, you can start the delay counter with the W. R. out pulse, count some number of clock pulses, and then supply an external trigger to the 7D01. See page 124 for complete details.

DD 501 Digital Delay

The DD 501 provides delay by events in a plug-in for TM 500 Mainframes. Using five thumbwheels on the control panel, the operator can set any desired delay from 1 through 99,999 events. When the number of input events reaches the preset count, the DD 501 will put out a trigger pulse which can be used for triggering a logic analyzer, oscilloscope, or counter.

For complete information and specifications see page 217.



A6701 Word Recognizer

Gate Emulation: AND, NAND, OR, NOR

Expandable in 18-bit increments

1 to 18 Bits at 50 MHz Clock Rate

Up to 72 Bits @15 MHz Clock Rate

Accommodates all Logic Families

Synchronous Qualified Clock and Level Modes

Glitch Filter

The new A6701 18 Bit Word Recognizer provides easy-to-use, uniquely configurable gate emulated triggering for digital troubleshooting. Besides conventional AND word recognition, the A6701 can be configured to provide NAND, OR, NOR or a combination of user-defined logic triggering. Both synchronous and asynchronous modes are provided along with such features as WORD-WORD selection, threshold voltage selection and glitch filter. In the synchronous mode, you may select either a level or qualified clock output.

For complete information and specifications see page 290.

WR 501 Word Recognizer with Digital Delay

The WR 501 is a 16 bit parallel Word Recognizer with digital delay that produces trigger pulses when a preselected word occurs. It occupies one plug-in position in any TM 500 Series Power Module Mainframe.

The WR 501 may be used separately as a word recognizer to generate triggers for oscilloscopes or other measurement instruments. It gives you fast access to any unique word in the data stream.

SPECIFICATIONS

Inputs — 16 data inputs plus a clock and qualifier.

Word Selection — Made using sixteen three-position toggle switches. Positions are HI, X (don't care), and LO.

Qualifier — Can expand the word recognizer to 17 bits, act as a gate for the external clock or do both.

Clock — Selects positive- or negative-going edge of clock input signal. Used for synchronous operation.

Modes — Front panel selection of synchronous word recognition (a trigger is produced only when the operator selected word occurs at a clock edge; either position, positive or negative edge, may be selected), or asynchronous word recognition (a trigger is produced anytime the recognized word occurs).

Synchronous Mode —

Minimum Set-up time	18 ns
Minimum Hold time	0 ns
(Filter is automatically disabled)	

Asynchronous Mode and Filter —
Minimum coincidence time is variable from 15 ns or less to 200 ns or more.

ORDERING INFORMATION

WR 501 Word Recognizer $1850

308 Data Analyzer

The 308 is a 20 MHz, four-in-one portable Data Analyzer. It provides Parallel Timing, Parallel State, Serial State and Signature Analysis, in an easy to use convenient package.

With the color coded keyboard you can easily control all the functions of the 308 Data Analyzer.

The 308's unique menu readout displays all of the status and operator mode information on its self-contained CRT. The status information is always displayed as the first line in all modes of operation. This provides you with instant identification of what you're doing before, during and after data acquisitions.

The 308 Data Analyzer provides data acquisition via one 8 channel high impedance probe (1 MΩ, 5 pF) for parallel timing and parallel state modes. For serial and signature acquisitions a single channel high impedance probe (10 MΩ, 13 pF) is used. All four modes are provided with a selectable threshold, TTL or Variable (+12 to −12 V), to allow data acquisitions from any digital logic family.

Input formats are selectable between Hexadecimal, Binary, Octal or Decimal. For the Parallel State Mode direct display of acquisition memory is provided in Hex, Binary and Octal simultaneously.

In the Serial State Mode the display provides readout in Hex, Binary and ASCII simultaneously, plus parity error indication.

In the Parallel Timing mode a unique selectable Memory Window is provided to allow you to select the section of acquisition memory you wish to view. The window size is programmable for 42, 84, or 168 bits of display width.

A cursor mode is provided for Parallel Timing, Parallel State and Serial State that gives word position information with respect to the delayed trigger word. For Parallel Timing the cursor provides decoding of the timing diagram in any one of the four formats.

The 308 Data Analyzer comes with an 8 x 252 bit Reference Memory to provide compare and "Restart If" functions. The Reference Memory "Restart If" function can be used in both Parallel modes and the Serial State mode.

The 308 can have up to 16 bits of external word recognition with an optional probe. The 308 provides a Word Recognizer Trigger Out signal (TTL) to trigger other external equipment. An external qualifier input, selectable for trigger or clock, is provided; and when used in conjunction with the 8 channel data probe, plus the word recognizer probe, yields a total of 25 bits of word recognition for triggering.

The 308 Signature Analysis portion gives signatures in two different modes, Repeat and Hold. In the Repeat mode, a signature is taken and displayed; once displayed the 308 takes another signature. This process repeats until the stop key is pressed. In the hold mode the 308 allows the acquisition of signatures manually. By pushing the Hold Key the 308 will acquire and display up to eight signatures simultaneously on the screen.

Data Analyzer

CHARACTERISTICS

Signal Inputs

Parallel Timing & State

Multiline probe-tip, 8 Data lines, 1 clock & 1 ground lead.

Maximum Number of Inputs — 8.

Input Impedance — 1 MΩ, 5 pF.

Logic Swing

Minimum — 500 mV +2% of threshold voltage p-p. centered on threshold voltage.

Maximum — ±40 V or less, to at least threshold voltage.

Maximum Non-destructive Input Voltage
−40 V to +40 V.

Width of Data Input — Minimum.
10 ns, with 400 mV overdrive from threshold voltage.

Threshold Voltage — Selectable.
TTL — +1.4 V to +0.2 V.
VAR — −12 V to +12 V.

Input mode — Selectable.
Sample or Latch (to 5 ns with 500 mV overdrive voltage).

Serial State

Single channel probe input

Input Impedance — 10 MΩ, 13 pF.

Non-destructive Maximum Input Voltage
500 V peak at probe tip
250 peak at bnc input connector.

Logic Swing
Minimum — 500 mV +2% of threshold voltage, peak-to-peak centered about the threshold.
Maximum — ±30 V peak.

Selectable Parity — ODD, EVEN or NONE.

Selectable Bits Per Character — 5, 6, 7 or 8 bits (includes parity if active).

Selectable Input logic — Positive or Negative (at probe tip).

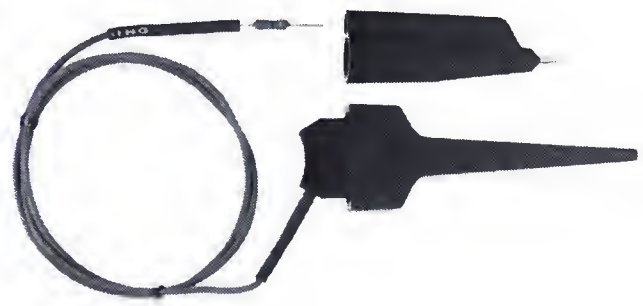
Synchronizing Word (Synchronous mode only) — Programmable to require two equal words. If not programmed defaults to ASCII word SYN.

Hunt Word (Synchronous Mode Only) — Programmable to require one word. If not programmed, defaults to "XXXXXXXX" (Not defined). One Hunt word is equal to 3 Hexadecimal "FF"s (Line idles).

Stop Bits (ASYNC ONLY) — Responds to one or more.

Signature Analyzer

Single channel data input via probe 10X — 10 MΩ; 13 pF Clock start, and stop inputs provided by Data Acquisition probe. Slip-on tip to allow characterization of tri-state buss lines.



Clock

Parallel Timing & State

External Clock: Period — Minimum — 50 ns.

Pulse Width, Minimum:
High-Logic Level — 24.5 ns.
Low-Logic Level — 24.5 ns.

Data Setup Time, minimum — 25 ns.

Data Hold Time, minimum — 0 ns.

Internal Clock: 20 MHz.

Sample Interval, minimum — 50 ns.

Data Pulse Width to ensure sampling
Minimum — 1 sample interval +10 ns.

Sample Intervals — 50 ns to 200 ns/sample in 1-2-5 sequence.

Qualifier Input

Selectable-Trigger or Clock

Input Threshold — TTL Level +1.4 V ±0.2 V.

Maximum Input Voltage — −5 V to +10 V peak.

Serial State

Synchronous or Asynchronous

Internal clock for asynchronous mode selectable via keyboard — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800 and 9600 bits per second (baud rate).

Internal Clock Accuracy = ±0.02%.

External Clock for Asynchronous mode — Up to 9600 baud.

External Clock for Synchronous mode — Up to 9600 baud.

Memory

8 X 252 bits Data Acquisition Memory.

8 X 252 bits Reference Memory.

Trigger

Parallel Timing & State

Synchronous or Asynchronous.

External Qualifier.

Data Word Recognizer — 8 Ch programmable in Hex, Binary, Octal or Decimal.

External Word Recognizer Probe — 16 Ch, programmable in Hex, Binary, Octal or Decimal.

Input threshold — TTL (+1.4 V +0.2 V).

Word Recognizer Trigger Out — TTL level (+1.4 V ±0.20).

Trigger Delay — Programmable from 0-65535 delay by clocks.

Data Position — Selectable in Pre- or Post-Trigger Positions, First Trigger Mode (Internal Select).

Serial State

Data Word Recognizer — Programmable to require a sequence of two words (or characters).

External Trigger — Programmable for one bit 0, 1, or "X".

Trigger Delay — Programmable from 0 to 65535 delay by word count (character).

Data Position — Selectable for Pre- or Post-Triggering.

Framing Error Detection — When a valid stop bit is not detected, data acquisition is stopped.

Display

Status information of the 308 is always displayed at the top of the screen. Also, the menu of the 308 is displayed with all fields visible. In the Serial State the 308 provides an extended menu for additional Serial capabilities.

Timing Diagram

Programmable Window Memory size.

Cursor Position Pointer and Word Decode.

Positive or Negative Display Logic.

Parallel State

Displays Hex, Binary & Octal simultaneously for quick decode.

12 Word Display Table.

Search Mode — Inverse video highlighting.

Compare Mode — Inverse video highlighting of differences

Positive or Negative display logic.

Serial State

Displays Hex, Binary, & ASCII simultaneously.

12 Word or Character Display.

Search Mode, Inverse Video Display of Word.

Compare Mode; Inverse Video Display of Differences.

Positive or Negative Display Logic.

Signature

Displays the edge selects for clock, start and stop. Also displays each signature taken simultaneously.

Displays a 4 digit signature.

Displays Characters — ∅ - 9, A, C, F, H, P, U.

PHYSICAL CHARACTERISTICS

1105 Power Supply provides 1.5 to 2 hrs. of nominal operation.

Size: 4.61 inches in height (11.7 cm), 9.3 inches wide (23.7 cm) with handle, 13.9 inches depth (35.9 cm).

Weight: 8 lb (3.7 kg) without probes, 10 lb (4.5 kg) with probes.

Power — 90 V to 132 V ac, 180 V to 250 V ac,

48 Hz to 440 Hz.

Consumption — 40 W maximum.

Temperature Range — 0 °C to 50 °C, operating.

Included Accessories — Each 308 Data Analyzer comes with an accessory pouch, one 8 channel Data acquisition probe, with harmonica connector, plus springed hook clips, a power cord and slip-on tip.

ORDERING INFORMATION

308 Data Analyzer	**$3500**
Option 01 P6406 Word Recognizer Probe	**Add $420**
1105 Battery Power Supply	**$1100**
Option 01, 230 V Operation	**No Charge**

The SONY®/TEKTRONIX® 308 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 308 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

```
PRL STATE.<HEX> SMPL.POST.POS
DATA[H]=0A              DLY[H]=0000
EXT [H]=XXXX-X          SMPL=   1µS

    HEX     76543210     OCT
CR= B2      10110010     262
    B2      10110010     262
    B2      10110010     262
DT=*0A****0000101****012*

    0A      00001010     012
    0A      00001010     012
    9A      10011010     232
    9A      10011010     232

    9A      10011010     232
    0A      00001010     012
    0A      00001010     012
    0A      00001010     012
```

```
SIGNATURE

CLOCK = ↑
START = ↓
STOP  = ↑

HOLD

                6 P C P <
                A 7 0 F <
                0 0 0 0
                0 0 0 0 <

                A 7 0 F <
                F 3 2 H <
                6 P C P <
                0 0 0 0
```

```
SER STATE.<HEX> SMPL.POST.POS
DATA 1[H]=0A            DLY[H]=0000
DATA 2[H]=54            ASYN= 9600HZ

    HEX     76543210    ASCII PE
CR= 0D      00001101     CR
    0A      00001010     LF
DT=*54****0101010****** T *
    48      01001000     H

    45      01000101     E
    20      00100000
    51      01010001     Q
    55      01010101     U

    49      01001001     I
    43      01000011     C
    4B      01001011     K
    20      00100000
```

Logic Analyzer Accessories

P6401 Logic Probe

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

State or Condition	Indication
Steady high state	Steady red light
Steady low state	Steady green light
Pulse trains (normal logic switching)	Blinking red and green light at full intensity
Abnormal state (between high and low)	No lights
Open circuit	No lights
Excessive input voltage greather than 6 V	Both red and green lights lit
Alternating between high state and indeterminate state	Blinking red light
Alterrnating between low state and indeterminate state	Blinking green light
Single or very low duty cycle logic pulse	Using STORE mode, one light will be on initially. Event has occurred when second light is lit.

SPECIFICATIONS

Low State Input Voltage Range — 0 V to +0.7 V ±0.125 V.

High State Input Voltage Range — 2.175 V ±0.125 V to Vcc.

Minimum Recognizable Pulse Width — 10 ns.

Impedance — ≈7.5 kΩ paralleled by ≈6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 kΩ.

Max Safe Input — ±150 V (dc or RMS).

Minimum Recognizable Strobe Pulse Width — 20 ns.

Max Safe Strobe Input — ±30 V (dc or RMS).

Strobe Input Impedance — 5.6 kΩ within 20%.

ORDERING INFORMATION

P6401 5 ft Probe (010-6401-01) $120

Includes: Hook Tip (206-0114-00)
Strobe Lead (175-0958-01)
Strobe Lead (175-0958-00)
Probe Tip to 0.025 in square pin adapter (206-0137-01)
White Plug (348-0023-00)
2 Alligator Clips (344-0046-00)
Accessory Pouch (016-0537-00) not shown

P6406/P6451 Probes

P6406 Replacement Word Recognizer Probe — For SONY/TEK 308 **only.**
(010-6406-03) **$440.00**

P6451 Replacement Active Probe —
(010-6451-03) For WR 501, 7D01, 7D01F, 7D01F2. Two probes are needed for 16 channel operation **$470.00**

(010-6451-05) For SONY® /TEKTRONIX® 308 **only**, with right-angle connector **$470.00**

BNC Cable — 50 Ω, 8 in
(012-0076-00) **$17.00**

1. **Retractable Hook Tip** — Suitable for use with P6401 Logic Probe.
(013-0106-00) **$7.75**

2. **Pomona Hook Tip to 6-32 —**
(344-0267-00) **$3.25**

3. **Probe Pin Tip** — Accepts 0.025 in IBM SLT pin. Slip on.
(206-0209-00) **$2.90**

4. **Probe Tip** — Flexible probe tip to fit 0.025 in square pin.
(206-0193-00) **$6.50**

5. **Miniature Alligator Clip —**
(344-0046-00) **$1.10**

6. **Clothes Pin IC Clip —**
(003-0709-00) **$26.00**

7. **Probe Pin Tip** — Accepts 0.025 in IBM SLT pin. Screw on.
(206-0134-03) **$3.50**

8. **Probe Ground Lead Adapter** — #6-32 to 0.025 in IBM SLT square pin.
(206-0137-01) **$1.50**

9. **Miniature Probe Tip Adapter** — For testing integrated circuits. Package of 10.
(015-0201-04) **$5.50**

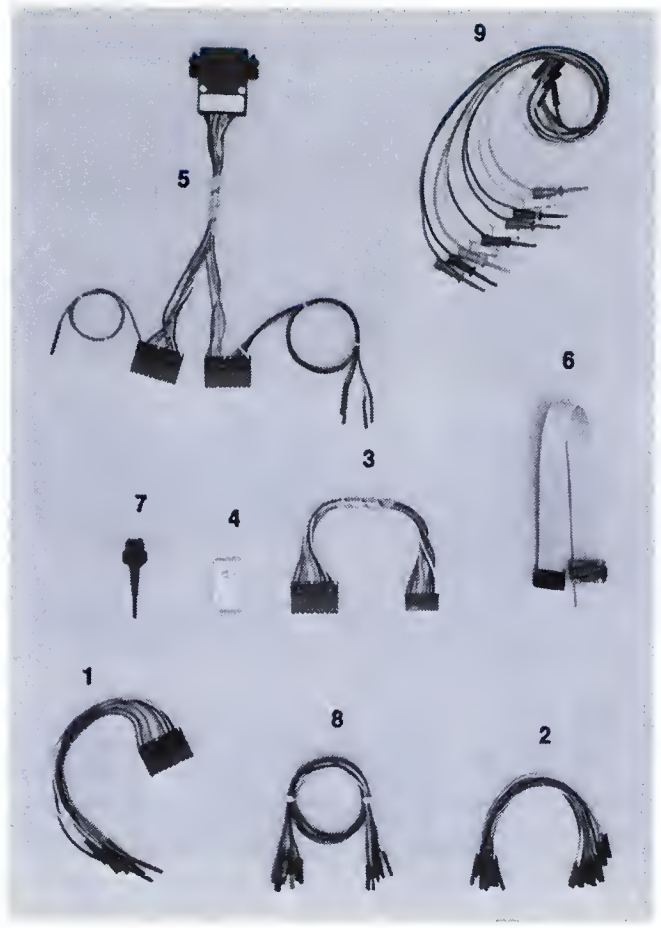
Additional accessories are described on pages 285, 288 and 289.

1. **10 Wide Comb** — 10 inch leads with grabbers not included.
(012-0747-00) **$40.00**

2. **20 cm Individual Connectors** — Grabbers not included.
(012-0655-02) **$70.00**

3. **10 Wide Comb** — With Harmonica Connector.
(012-0800-00) **$20.00**

4. **Clothes Pin IC Clip —**
(003-0709-00) **$26.00**



5. **GPIB Connector —**
(103-0209-00) **$75.00**

6. **16 Pin Low Profile Dip Clip** — Can be used with 14 or 16 pin IC's.
(015-0330-00) **$25.00**

7. **Grabber Tip —**
(206-0222-00) **$2.75**

8. **40 cm, Color Coded Replacement Lead Set*** — For the P6450 Probe or the P6451 Probe. 10 leads/set connects probe lead to 0.025 in, square pins.
(012-0655-01) **$40.00**

9. **40 cm Individual Connector*** — 10 wire with Pomona Grabbers.
(012-0670-00) **$65.00**

*Note: EMI can exist with the 40 cm length. This can be a problem if using a digital latch.

40 Pin Low Profile Dip Clip — 10 cm cable (order M/F adapter below) **015-0339-00** **$40**

40 Pin Low Profile Dip Clip — 30 cm cable (orde M/F adapter below) **015-0339-02** **$40**

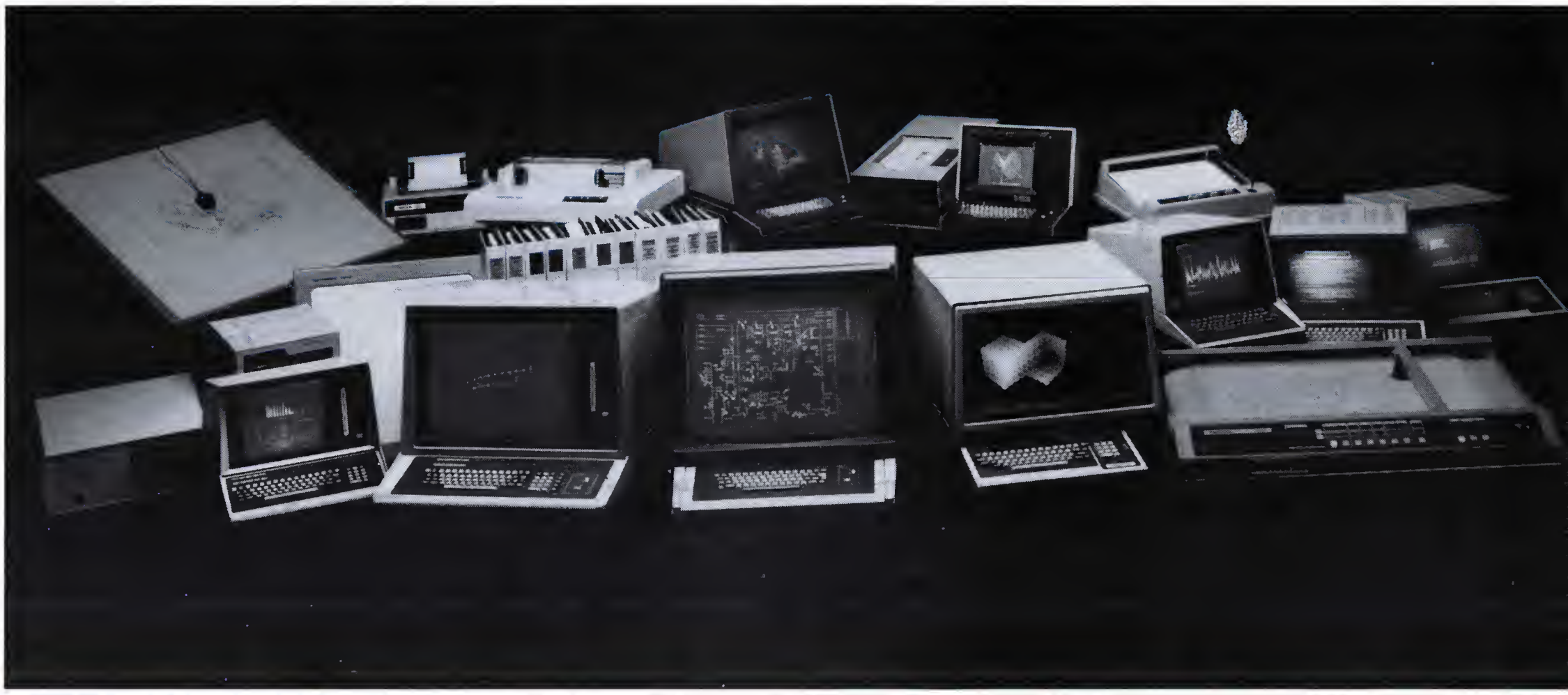
Male Adapter for 40 Pin Low Profile Dip Clip — For use with PM 101/7D02 General Purpose Personality Module (or with individual leads such as the 10-wide comb set 012-0747-00)
380-0560-05 . . . . . **$6.25**

Female Adapter for 40 Pin Low Profile Dip Clip — For use with dedicated 7D02 personality modules **380-0647-01 $9.25**

Probe Holder — Clip-on holder accommodates probe pod for P6451.
(352-0473-01) **$2.75**

BNC Cable — Used with the Digital Latch
(012-0118-00) **$16.00**

Computer Graphics Products



"The Graphic Standard"

Graphics, the true universal language. For 12 years, Tektronix has set the standards by which graphics information is measured. In resolution. Size. Software. Service. Reliability. Compatibility. And breadth of product line. Whatever your own standards of productivity and graphics performance, you can turn to Tektronix.

For additional product information and details on interfacing, software and accessory support, please indicate your interest on the reply card at the back of the catalog.

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Computer Display Terminal

4014-1/4015-1

19 in (48.3 cm), Direct-View Storage Display

Selectable Formats in Alphanumeric and Graphic Modes

High-Resolution, Interactive Graphics Capability

Plug-In Intelligence Options

APL Character Set Available

We've added some intelligent choices to the choicest of graphics. Tektronix' famous 4014-1 has long been a favorite for display of large data bases and precise detail. Its flicker-free 483 mm (19") screen offers priced-right performance for applications in mapping, design, manufacturing, medicine, energy exploration and many other diverse disciplines.

Recently, Tektronix has augmented the 4014-1 and APL language 4015-1 performance with plug-in firmware options adding powerful firmware capabilities like keyboard programmability, local symbol design, scaling, clipping and rotation. In many instances, they can reduce data transmission costs by 50 percent or more, with the aid of local interactive intelligence.

Big Screen. Big Features. The 4014-1 and 4015-1 offer 1024 (x) by 780 (y) displayable points standard and up to 4096 (x) by 3120 (y) displayable points with the optional Enhanced Graphics Module. Its 12 million point capability is more than sufficient to solve most complex mapping and design tasks. Full 96-character ASCII includes four program-selectable alphanumeric formats which display up to 8512 characters at once.

Of course, the 4014-1 and 4015-1 are immediately compatible with the full range of Tektronix peripherals, including the 4631 Hard Copy Unit, the 4923 Digital Cartridge Tape Recorder, B-Size 4662 and C-Size 4663 Interactive Digital Plotter, plus others. Optional minibus extender allows expanded accessory and peripheral capability. And Tektronix PLOT 10 Software provides a library of proven graphics packages. PLOT 10 offers versatile modular software for all levels of users. PLOT 10 Terminal Control System to link to existing applications, PLOT 10 Easy Graphing for rapid generation business or scientific graphs. For device independent applications projects add our PLOT 10 Interactive Graphics Library.

Options 5, 40 and 41: local enhancements with up to 26K of RAM. Attractively priced, this series of local capabilities lets you recall complex displays with a single keystroke.

You can enlarge, reduce and rotate picture elements with ease. You can design your own stroke-drawn characters and symbols, and position them anywhere on the screen using the built-in crosshair cursor. You can also command local and program control of Tektronix tape drive, plotters, the 4907 File Manager and 4953/54 Graphic Tablets. You enjoy maximum graphic interactivity without mainframe costs or transmission line glitches.

The 4014-1 has become standard equipment to many phases of research, medicine, engineering, business, energy-related fields, cartography, manufacturing and others where its price/performance practically lends itself.

Tektronix offers maintenance training classes on instruments in the 4010 DVST Graphic Terminal Series. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

SPECIFICATIONS

Display Medium — Direct View Bistable storage crt.

Display Area — 15 in (38.1 cm) wide x 11 in (27.9 cm) high.

Alphanumeric Mode — 4014-1 Full ASCII character set (94 printing characters).
4015-1 Full ASCII and APL character sets (188 total printing characters).

Character Format — Four program-selectable formats:
1) 74 characters per line with 35 lines per display.
2) 81 characters per line with 38 lines per display.
3) 121 characters per line with 58 lines per display.
4) 133 characters per line with 64 lines per display.

Alphanumeric Cursor — 7 x 9 dot pulsating cursor.

Keyboard — Typewriter paried upper and lower case with auto repeating keys. 4015-1 adds APL character set.

Graphics Mode — Vector drawing time 5,000 in/s (127 m/s).

Information Density — 1024(x) by 1024(y) addressable points (10 bits). 1024(x) by 780(y) viewable points.

Interactive Graphic Mode — Thumbwheel controlled crosshair cursor. 3 thru 1024 addressable points horizontally. 0 thru 780 addressable points vertically.

ORDERING INFORMATION

4014-1 Computer Display Terminal with Standard Data Communications Interface $13,450

Option 34, Enhanced Graphics Module (factory installed only) ..... Add $925

4015-1 Computer Display Terminal with Standard Data Communications Interface $15,400

Option 34, Enhanced Graphics Module (factory installed only) ..... Add $925

OEM terms available on these products.

4016-1

25 in (63.6 cm) Direct-View Storage Display

High-Resolution, Flicker-Free Graphics

Selectable Formats in Graphic and Alphanumeric Modes

Plug-In Intelligence Options

The easiest viewing, most exceptional graphics ever. The 4016-1 was built for designers of electronic ciruit boards, utility networks, automotive components, schematic diagrams, street maps or similar applications who need to work with fine detail while maintaining the total picture perspective.

With its big 635 mm (25") diagonal screen, 4096 (x) by 3120 (y) viewable points, and finely etched 10 mil wide vectors, the 4016-1 is uniquely suited for displaying highly complex graphics. Using a Direct View Storage Tube (DVST) display, graphic lines are sharp, stable and flicker-free, simplifying the study of fine details. Thumbwheel-controlled crosshair cursor makes it easy to interactively manipulate the display.

Over 15,000 displayable characters. Besides enabling display of more high density graphic information than any other terminal available, the 4016-1 provides high density alphanumerics for applications, from graphic labeling to newspaper page layout. Over 15,000 characters may be displayed simultaneously and may be formatted as 179 alphanumeric characters per line, like a line printer, or in two 85 character columns, like an open book.

Three other larger character formats are standard with the 4016-1, the largest of which is suitable for group viewing.

Complete Tektronix 4014-1 compatibility. The 4016-1 is compatible with 4014-1 application software, communication support, and other Tektronix peripheral devices. The 4016-1 is supported by the family of PLOT 10 software products.

Plug-in intelligence. Using the modular 4010 bus structure, add-on low-cost options include up to 26K of usable graphics display memory, scaling, relative graphics, clipping, circular arc generation, rotation by 1° increments, user definable stroke characters, programmable keyboard, GPIB interfacing to the intelligent 4924 Digital Cartridge Tape Drive, 4907 File Manager, and 4662 and 4663 Interactive Digital Plotters, plus the 4953 or 4954 Graphics Tablet.

Commands also allow a user to digitize data with distance, time, or gradient filtering; edit graphics from a host computer, local 4907, 4924 storage device or Option 40 programmable keys. Implement off-line plotting by accessing data via local storage devices.

Added enhancements. The 4016-1 includes a convenient detachable keyboard and detachable display.

Other standard enhancements include hardware generated solid, dashed, and dotted lines; point plotting with software controllable point sizes and incremental "relative graphics" plotting.

Hard copy compatibility provides 216 mm x 279 mm (8½" x 11") hard copies from our dependable, dry-process 4631 Hard Copy Unit.

Tektronix offers maintenance training classes on instruments in the 4010 DVST Graphic Terminal Series. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

SPECIFICATIONS

Display Medium — Direct View Bistable storage CRT. Written image bright green on green background.

Display Area — 18 in (45.4 cm) wide x 13.5 in (34 cm) high.

Character Set — Full ASCII character set (94 printing characters).

Standard Character Format
1) 74 char/line by 35 lines.
2) 81 char/line by 38 lines.
3) 133 char/line by 64 lines.
4) 179 char/line by 86 lines.

Optional Character Formats
1) 74 char/line by 35 lines.
2) 81 char/line by 38 lines.
3) 121 char/line by 58 lines.
4) 133 char/line by 64 lines.

Alphanumeric Cursor — 7 x 9 dot pulsating cursor.

Keyboard — Typewriter paried upper and lower case with auto repeating keys.

Graphics Mode — Vector drawing time is 8000 in/s (20,000 cm/s).

Information Display — 4096(x) by 4096(y) addressable points (12 bits). 4096(x) by 3120(y) viewable points.

Vector Formats — 5 formats, including straight, dotted and dashed lines.

Point Plotting Modes — Point Plot Mode: special Point Plot Mode absolutely addresses points with program control of plotted point size. Incremental Plot Mode relative addressing 1 of 8 directions, one step at a time.

Interactive Graphic Mode — Thumbwheel controlled crosshair cursor. 0 thru 1023 addressable points horizontally. 0 thru 780 addressable points vertically.

Hard Copy Mode — Switch selectable hard copy of screen using the 4631 Hard Copy Unit.

ORDERING INFORMATION

4016-1 Computer Display Terminal with Standard Data Communications Interface $19,500

OEM terms available on these products.

Color Graphics Terminal

4027

Full Color Graphics and Alphanumerics

PLOT 10 Compatible

Fully Supported Color Capability

Dynamic Displays Created Easily

Tektronix makes it practical to add the color dimension. The 4027 offers all the easy data entry, scrolling, and graphics capabilities of the Tektronix high performance 4020 raster-scan family. Most importantly, it provides the kind of fully supported color capabilitiy you could expect only from the world's graphics leader.

Full-color graphics, easy to grasp. Colors are selected from a 64-color palette with up to eight colors displayable simultaneously. For specifying lightness, saturation and hue, you'll find the 4027 system as easy as it is versatile.

Local capabilities include colored vectors, characters, symbols, and polygon fill. Firmware enables a second color to border the polygon. . . and allows user selection of up to 120 different patterns or color combinations for sepcial applications. Because the capabilities are initiated by firmware, not software, 4027 operation makes minimal demands on host computer communications.

Easy-to-use graphic software. For graphic representation, the 4027 uses color-enhanced PLOT 10 Easy Graphing Software. Easy Graphing simplifies even non-programmer construction of up to six curves or colored bar charts, line graphs with special symbols and dashed lines, legends, titles, and grids.

For more general color graphic applications, Tektronix offers the new PLOT 10 Interactive Graphics Library. IGL is a highly modular package offering all the support commonly required in graphic applications such as 3-D, color panels, line smoothing and many character fonts. PLOT 10 IGL is upward and downward compatible with the full line of Tektronix graphic display terminals.

Graphic input. Graphic input capability consists of a graphic crosshair cursor controlled by graphic cursor keys. In addition to reporting the coordinates back to the host, the terminal also reports the color of the designated coordinate.

Up to 32K bytes of built-in display memory, and up to 192K bytes of graphic memory, allow the same scrolling, dual screen and multiple field formatting featured in other 4020 Series terminals.

The optional video signal output allows connection of the 4027 to external video displays for group viewing and presentations.

Gray scale representations of 4027 color displays can be made with a Tektronix 4632 Video Hard Copy Unit. Detailed, camera-ready color copies of graphs and alphanumeric data can be made on paper or acetate via the Tektronix 4660 Series of Interactive Digital Plotters.

To the standard full duplex, 4027 interface options add half duplex, current loop, polling interface and IBM 3270 compatible polling controller.

All this and alphanumerics, too. In addition to graphic capabilities, the 4027's extensive alphanumeric capabilities include full ASCII, special and user-definable character sets, and 34 rows of 80 characters.

4027 SPECIFICATIONS

Display Size — 10 in (25.4 cm) wide x 7.5 in (19.1 cm) high.

Graphics — Standard with full screen crosshair cursor.

Color — 8 colors displayable, colors selected from a pallette of 64 colors.

Patterns — 120 user definable color patterns.

Local Functions — Circle and pie generation, polygon fill.

Other 4027 specifications — Same as 4025.

ORDERING INFORMATION

4027 Color Graphics Terminal $8695

OEM terms available on these products.

Tektronix offers maintenance training classes and user application workshops on instruments in the 4020 Raster Scan Terminal Series. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

4024

Complete Alphanumeric Terminal

Easy To Use For The Novice As Well As The Experienced Programmer

Forms Ruling Options Available

Easy Interface, Optional Polling

The 4024 is everything you need for data entry, editing and forms fill-out. It was designed to allow fast, straightforward interaction with your host computer and maximum efficiency in the manipulation of alphanumeric data. In writing and editing programs. Editing text. Or filling out and editing forms.

Easy-to-use for the novice as well as the experienced programmer. The 4024 can display a full 34 lines of 80 characters each on its 304 mm (12") diagonal display screen. The complete upper and lower case ASCII character set is provided. The keyboard is in the familiar office typewriter configuration.

Predefined editing keys let you insert and delete lines and characters. Twenty user-definable keys, plus nearly any other key on the keyboard, can be defined to generate a command or character string at the touch of a finger. This lets a programmer or other user quickly restructure the keyboard to suit a particular need. Our green-on-black screen with adjustable brightness level is easy on the eyes.

A 4K memory is standard with the 4024, but can be expanded to 32K, allowing buffering and scrolling of hundreds, even thousands of words.

Develop or duplicate forms of any complexity with a variety of single and multiple horizontal and vertical rules selected from the Ruling Character Set. Expandable memory and scrolling let you create forms far beyond the length of the display screen.

To make data entry and editing easier, you can divide the display screen into two separate display areas, each with independent scrolling. Use the monitor area to communicate with the host and the workspace area for the form itself. Visual attributes include enhanced and blinking fields. Logical attributes include protected fields, modified, alphanumeric or numeric only.

The "send modify" command streamlines data entry by transferring only the modified, keyed-in data to the host. The fixed format remains ready for the next series of entries.

Operation is easy for anyone, because the 4024 uses English language commands based on the ASCII character set.

SPECIFICATIONS

Display Size — Video monitor display on 12 in (30 cm) diagonal screen.

Raster Lines — Standard 525 line scan, with 480 lines displayed. Scan — 30 Hz.

Display Characteristics — Cursor Type. Wide underscore. Character size — 7 x 9 in a 8 x 14 dot matrix.

Character Sets — 64/96 upper and lower case ASCII. 80 characters/line, 34 lines/display. 2720 Total characters/display.

Baud Rates — The transmitting and receiving baud rates are independently selectable using internal strap selection. The baud rates available are: 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600 baud.

ORDERING INFORMATION

4024 Computer Display Terminal $3200

4025

From Alphanumerics To Graphics

ASCII Character Set and Finger Tip Editing

Forms Ruling Option Available

The 4025 creates the perfect marriage of alphanumerics and graphics. You can create and store multiple graphs in memory, create multiple graphs per page, and scroll graphics along with alphanumeric information.

The 4025 gives you the ability to expand a computer terminal from basic alphanumerics, to forms ruling and then to graphics. No other terminal has such versatility up to and including the capacity for unsurpassed report generation.

Start with an ASCII character set and fingertip editing. In its simplest configuration, the 4025 can display a full 34 lines of 80 characters each on its 279 mm (12") diagonal display screen. Complete upper-and lower-case ASCII character set is provided. Green-on-black display with adjustable brightness level keeps even long sessions easy on the eyes.

The keyboard, an office typewriter configuration, is immediately familiar to new users. Pre-defined editing keys simplify insertion, deletion and input of lines and characters. Thirteen user-defineable keys, plus nearly all other keys on the keyboard can be redefined to generate a command or character string at the touch of a finger.

A 4K memory is standard with the 4025 display, expandable to 32K, allowing buffering and scrolling of hundreds and even thousands of words.

SPECIFICATIONS

Display Size — Video monitor display on 9 in (22.9 cm) wide x 6.4 in (16.3 cm) high.

Raster Lines — Standard 525 line scan with 480 lines displayed.

Character Set — 64/96 upper and lower case ASCII (optional character sets available).

Alphanumeric — Mode format is 34 lines, 80 characters per line, 2720 characters full screen.

Character — Generation — 7 x 9 in an 8 x 14 dot matrix (graphic cells are 8 x 14 matrix).

Cursor — Wide underscore.

Baud Rate — Selectable to 9600 baud.

Graphics — Optional.

ORDERING INFORMATION

4025 Computer Display Terminal $3800

OEM terms available on these products.

Computer Display Terminals

4006-1
Computer Display Terminal

Low Cost

Flicker-free High Resolution

Graphic and Alphanumerics

The 4006-1 is one of four solutions towards making interactive, high-resolution graphics affordable to cost-conscious disciplines and departments. Priced no more than many alphanumeric terminals, the 4006-1 makes graphic capability practical for the stock room, the classroom and the conference room as well as for other graphic applications.

The 4006-1 connects readily to most mainframes, thanks to its RS-232-C interface. With a screen capacity of 2590 alphanumeric characters in addition to graphics capability, the 4006-1 can work in configuration with existing alphanumeric terminals to interpret statistics and coordinates into meaningful charts, tables, graphs and diagrams.

SPECIFICATIONS

Display Medium — Direct View Bistable Storage CRT.

Display Area — 7.5 in (19.5 cm) wide x 5.6 in (14.2 cm) high.

Alphanumeric Mode Format — 35 lines, 74 character per line. 2590 characters full screen.

Character Set — 63 printing characters (TTY ANSI Code).

Character Generation — 5 x 7 dot matrix.

Cursor — 8 x 8 dot matrix.

Graphics Display Mode — Vectors only. Vector drawing time, 3.6 ±0.2 ms.

Information Density — 1024 (x) by 1024 (y) addressable points. 1024 (x) by 780 (y) viewable points.

Baud Rate — Transmit and receive independently. Selectable from 75 to 4800 baud.

ORDERING INFORMATION

4006-1 Computer Display Terminal . . . $2995

Option 01, Data Communications Interface . . . . . Add $350

4010-1
Computer Display Terminal

Supports Alphanumerics Plus Low-Cost Computer Graphics

Convenient Bus Structure for Peripheral Add-On

Complete PLOT 10 Software Support

Graphic Input

The 4010-1 Computer Display Terminal is an easy to use, cost effective tool that brings out the best of Tektronix' famous graphics capability. Included are flicker-free display, high-resolution graphs, charts, diagrams and renderings produced on a matrix of 1024 (x) by 780 (y) viewable points and interactive graphics construction via thumbwheel cursor control.

The standard TTY-style keyboard enables easy data entry. Command of both alphanumeric and graphic display is so immediate that hours of hand drafting can become the matter of a few seconds.

SPECIFICATIONS

Display Medium — Direct View Bistable Storage CRT.

Display Area — 7.5 in (19.05 cm) wide x 5.6 in (14.22 cm) high.

Alphanumeric Mode Format — 35 lines, 74 characters per line, 2590 characters full screen.

Character Set — 63 printing characters (TTY ANSI Code).

Character Generation — 5 x 7 dot matrix with MOS Read-Only Memory. 1200 characters per second.

Cursor — Pulsating 5 x 7 matrix.

Graphic Display Mode — Vectors only. Vector drawing time 2.6 ms.

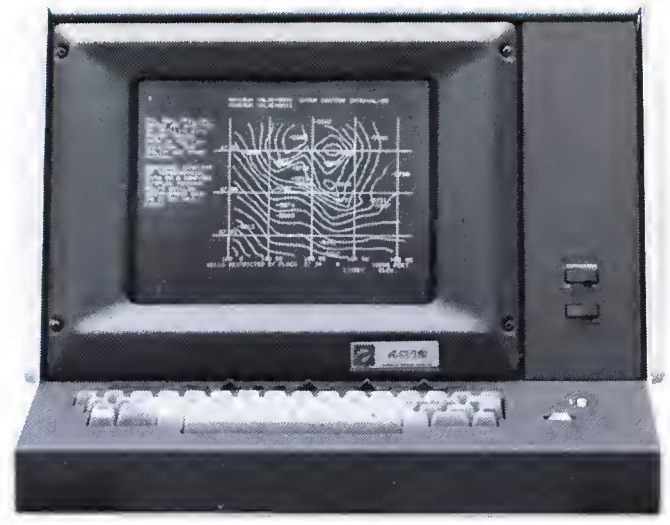
Information Density — 1024 (x) by 1024 (y) addressable points. 1024 (x) by 780 (y) viewable pionts.

Graphic Input Mode — Thumbwheel controlled cross-hair cursor. 3 through 1023 (x) 0 through 780 (y).

ORDERING INFORMATION

4010-1 Computer Display Terminal with Standard Data Communication Interface $5200

Tektronix offers maintenance training classes on instruments in the 4010 DVST Graphic Terminal Series. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.



4012
Computer Display Terminal

High-Resolution, Flicker-Free Graphics

Full Upper and Lower Case ASCII Character Set

Conventional Bus Structure For Peripheral Add-On

The 4012 combines the world's leading graphics with complete alphanumerics. Alphanumerics can tabulate computer data, but graphics can amplify that data into usable, immediately meaningful information. High-resolution graphic presentations and the full upper and lower-case ASCII alphanumerics are available in the 4012.

The flicker-free screen provides up to 1024 (x) by 780 (y) viewable graphic points or as many as 2590 A/N characters per display. The TTY-style keyboard simplifies input while the thumbwheel controlled crosshair cursor enhances graphic interactivity. With thumbwheel control, user can direct the x-y cursor for speedy additions or deletions of data to the display screen.

SPECIFICATIONS

Display Medium — Direct View Bistable Storage CRT.

Display Area — 8 in (20.3 cm) wide x 6 in (15.2 cm) high.

Alphanumeric Mode Format — 74 characters per line; 35 lines per display; 2590 characters per display.

Alphanumeric Cursor — Pulsating 7 x 9 dot matrix.

Character Set — 94 printing characters on 7 x 9 dot matrix. (Full ASCII code).

Character Size — 85 mils x 105 mils.

Character Generation — 7 x 9 dot matrix with MOS Read-Only Memory. 1,000 characters per second.

Graphic Mode — Vectors only. Vector drawing time 2.6 ms.

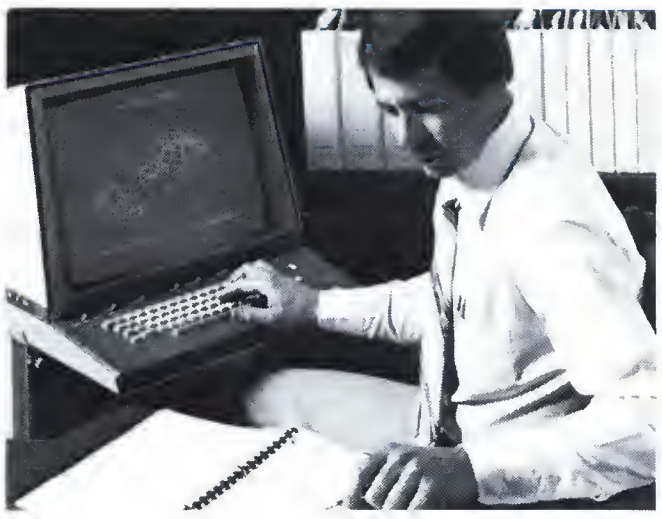
Graphic Matrix — 1024 (x) by 1024 (y) addressable points. 1024 (x) by 780 (y) viewable pionts.

Graphics Input Mode — Thumbwheel controlled cross-hair cursor. 3 through 1023 (x) 0 through 780 (y).

ORDERING INFORMATION

4012 Computer Display Terminal with Standard Data Communication Interface $7500

OEM terms available on these products.



PLOT 10
Graphics Software Library

PLOT 10 is the world's leading commercial graphics library. Versatile, modular, and fully documented, it lets you start with only the code you need to do your job, then expand with modules and utilities to develop more sophisticated or specialized applications. PLOT 10 builds to high-level, "cookbook" solutions such as English-like commands for business applications and other non-programmer environments.

PLOT 10 includes the following packages:
Terminal Control System (TCS) — A composite of FORTRAN IV subroutines, TCS contains the basic building blocks for all graphic operations. It permits modular as well as system independent programming, and supports such basic graphic functions as windowing, clipping and rotation for DVST terminals and 4660 Series Plotters.

Plotter Utility Routines — Those routines link your data base, terminal and Tektronix 4660 Series plotters to enable easy, powerful command of multicolored graphs, charts, maps and renderings. Digitizing is just as versatile by using the built-in joystick.

Advanced Graphing Package — AG II subroutines let a programmer tailor the size, shape and format of graphs, specifying more than 40 graphic elements.

Interactive Graphing Package — IGP simplifies the task of graph storage, editing, recall and updating, so a user with little or no programming experience can create a presentation quality graph, on DVST terminals.

Easy Graphing — A straightforward English lanquage command structure that gives the non-programmer wide-ranging command of graphics in business and engineering decision-making tasks.

Interactive Graphics Library — IGL is a uniquely modular system of I/0, device drivers, primary commands and advanced feature support that lets the user move at will among any Tektronix display devices or technology. Advanced options such as color panel filing, many character fonts and 3-D may be added.

PLOT 10 ORDERING INFORMATION

For 4010 Series Terminals. 4006-1, 4025 and 4027 color display.

Tools for easy use of graphic and alpha-numeric capabilities of Tektronix Terminals.

4010A01 PLOT 10 Terminal Control System $1500

4010A10 PLOT 10 Terminal Control System, Implementation for IBM with TSO $1750

4010A12 PLOT 10 Terminal Control System, Implementation for PDP-11 with DOS .$1500

Versatile software to graph your data using a powerful set of FORTRAN IV subroutines.
4010A02 PLOT 10 Advance Graphing II $2000

Complete Support for TEKTRONIX 4013 and 4015 with self documenting commands, for the APL Programmer.
4010A09 PLOT 10 APL GRAPH II $1500

4010A13 PLOT 10 APL GRAPH II, Implementation for APL/360 .....$1800

Powerful graphing through English language commands for the non-programmer
4010A03 PLOT 10 Interactive Graphing Package $2250

Correct your graphics easily with a Tektronix Terminal before plotting.
4010A04 PLOT 10 Preview Routines for CalComp Plotters $500

Provides complete flexibilty of character definition, including rotation, scaling, and special characters.
4010A05 PLOT 10 Character Generation System $225

Point by point Tektronix 4953 and 4954 support, plus pencil and paper input ease for many computer systems.
4010A06 PLOT 10 Graphic Tablet Utility Routines $200

Individual addressing of up to 12 Tektronix displays.
4010A08 PLOT 10 Display Multiplexer Utility Routines $150

Office machine simplicity for the production of the most popular formats in graphing.
4010B01 PLOT 10 Easy Graphing Punch Paper Tape $1380

4010B02 PLOT 10 Easy Graphing 026 Format Punched Cards $1380

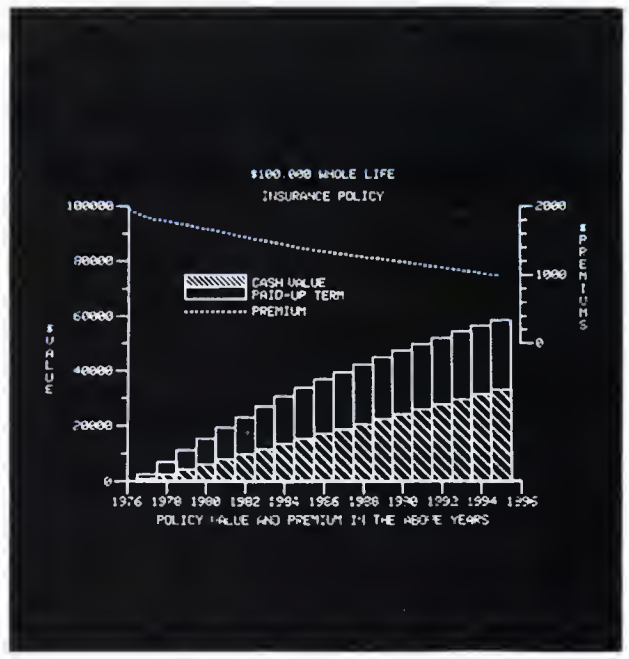
4010B03 PLOT 10 Easy Graphing Magnetic Tape $1950

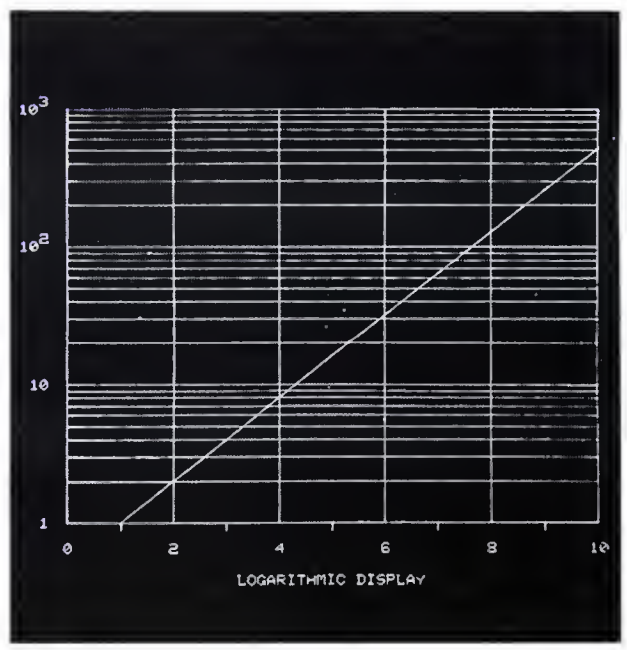
4010B04 PLOT 10 Easy Graphing Dec RK-05 Hard Disc $1480

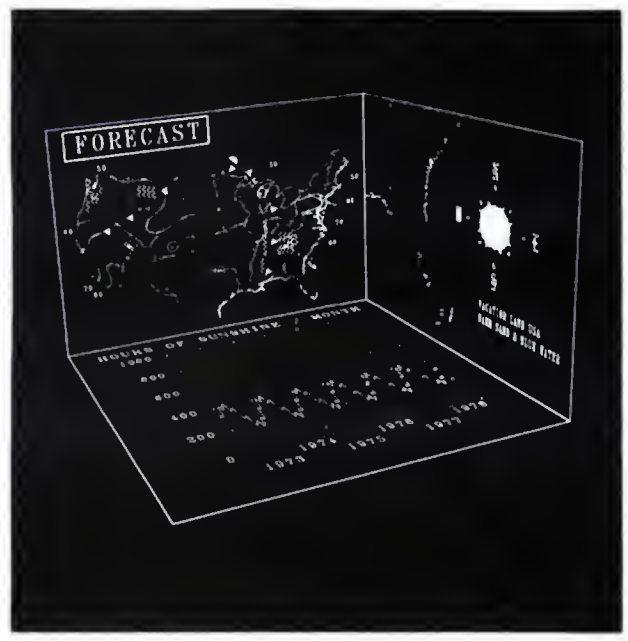
4010B05 Easy Graphing 029 Format Punch Cards $1380

Designed for device independent control of DVST, raster scan displays, and plotters. Offers a growing array of graphics control functions such as commands for color, 3-D, line smoothing, and multi font text manipulation.

4010C01 PLOT 10 Interactive Graphics Library $2500-10,000







Desktop Computers

4051 Desktop Computer

Low Cost

High Resolution

Graphics and Alphanumerics

GPIB Product

Desktop computing for a whole spectrum of problem solving, data analysis, and decision making applications. The 4051 is a stand-alone computer that is approachable, affordable, and able to grow as your applications grow. From the day you plug it in, the 4051 performs productively by putting solution-oriented BASIC language and meaningful graphic information at your fingertips.

Friendly graphics. Commands like DRAW and ROTATE built into the 4051 give you full graphics flexibility while working in your units, not machine or raster units. Easy graphics accelerates analysis, decision making and model building. It supplements your intuition and gets your point across by making information easy to understand. Once you use graphics you'll wonder how you got along without it.

The GPIB bus is built-in and easy to program with the 4051 BASIC I/O commmands. As the industry's choice for connecting instrumentation it is our choice for the 4051 and its many available peripherals.

It includes integrated computing, peripherals, and a GPIB (IEEE Standard 488-1978) interface. You don't have to know how the internal processor works to use it, you simply use the graphically-enhanced BASIC commands.

A 300K bytes magnetic cartridge tape drive is built into the 4051 hardware and language. No bits, no status words to check. File management commands like FIND, OLD, READ, and WRITE, retrieve or store programs and data. A comfortable typewriter keyboard is integrated into the system with a 28-character buffer that eliminates lost entries.

Friendly, extended BASIC provides both power for the sophisticated programmer and simplicity for the beginner. Input and output operations are easy to program and debug because the 4051 commands use device independent keywords. Input and output can be as simple as INPUT or PRINT or can have FORTRAN like power with PRINT, DELETE and IMAGE commands.

A data communication option permits sharing data with a host computer. The asynchronous RS-232 interface lets you choose terminal mode communications at up to 2400 baud. Terminal modes provide performance like our popular 4012 Computer Display Terminal with local intelligence and direct data transfer between the built-in cartridge tape drive and host computer.

SPECIFICATIONS

Processor — LSI 8 bit microprocessor.

User Memory Workspace — 8K bytes standard, expandable to 32K bytes.

Keyboard — Full 128 ASCII character upper and lower case with auto repeat. 10 key numeric and 5 math function calculator key pad. Line/character editor keys.

User definable function keys — 10 shiftable to 20. Keys for single step execution of programs, auto-numbering, rewinding magnetic tape, or automatic loading and execution of the first program on tape.

Tape Drive — 3M DC 300A cartridge. 300K bytes maximum (dependent on number of files).

Rewind speed — 90 ips.

Search/read speed — 30 ips.

Structure — 256 bytes with header. File oriented access via BASIC commands

CRT — Direct view storage CRT.

Alphanumeric — 72 characters per line, 35 lines.

Character set — Full ASCII including upper/lower case. Also includes Scandinavian, German, General European, Spanish, and special graphic symbol fonts.

Graphic resolution — 1024 x 780 points.

Visibility — Flicker-free, easy-on-the-eyes display.

Copier — Compatible with Tektronix 4631 Hard Copy Unit.

ORDERING INFORMATION

4051 Desktop Computer System $5995

Option 20 16K bytes total memory . . . . . Add $900
Option 21 24K bytes total memory . . . . . Add $1400
Option 22 32K bytes total memory . . . . . Add $1900

The 4051 and 4052 are designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Control, Talk, Listen.

4052 Desktop Computer

Fast Processing

High Level BASIC

Expandable Memory

GPIB Product

High performance computation and communications for a whole spectrum of problem solving, data analysis, and decision making applications. The 4052 is a desktop computer offering high performance, stand-alone computing power, flexible data communications, and easy-to-learn, extended BASIC. These features, combined with high resolution graphics, make the 4052 an excellent choice for scientific and statistical research, forecasting, data acquisition and analysis.

The 4052 is an integrated system offering all the tools necessary to immediately begin providing relevant solutions. For rapid calculation, the 4052 has a fast processor with microcoded floating point. The state-of-the-art graphics capabilities of the 4052 provide for demand hard copy of any combination of text and high-density graphics (with optional hard copy unit). Fast processing coupled with simultaneous display of text and graphics meets the needs of most application requirements.

The 4052 comes standard with 32K bytes of memory, and can be optionally expanded to 64K bytes, allowing larger and more complex programs to be handled. A 300K bytes magnetic cartridge tape drive is built-in, allowing both ASCII and binary programs or data to be easily stored and retrieved using simple file management commands in BASIC. The 4052 keyboard retains the familiar, easy-to-use format of the 4051 typewriter keyboard, yet contains subtle changes made with the user in mind like sculptured keys and non-glare keycaps.

A Family and a System. Our 4051 set the standard for high performance, affordable desktop computing. Following in the 4051's footsteps, the 4052 offers a faster processor and larger memory capacity. The 4054, with a processor similar to the 4052, offers enhanced graphics on a 19" DVST screen. Combined, they make up the 4050 Series, the only desktop computer line with software compatibility. Programs developed on a 4051 will operate on the 4052 and the 4054 without modification.

The 4050 Series continues to set the standards for high performance, easy-to-use desktop computers. Flexible GPIB and RS-232 interfacing to a wide variety of proven peripheral products allows considerable versatility in designing a system to fit your needs. Additional peripherals can be readily integrated as your application needs grow.

Friendly extended BASIC provides the simplicity desired by the beginner and the flexibility and power required by the experienced programmer. Device independent keywords such as INPUT and PRINT make progamming input and output operations easy. Fast matrix functions such as multiply, inverse, transpose, identity and determinants are built into BASIC.

Friendly graphics. Commands like MOVE, DRAW and ROTATE in BASIC allow graphic displays to be created on the 4052 using user defined units, not machine or raster units. Using graphics to display information accelerates analysis, decision making, and model building. It supplements your intuition and gets your point across by making information simple to understand.

SPECIFICATIONS

Processor — LSI bi-polar 16 bit.

User Memory Workspace — 32K standard, expandable to 64K.

Keyboard — Improved, sculptured, matte finish. Keyboard identical in other specifications to 4051 keyboard.

Tape Drive — Identical to 4051 tape drive but provides faster storage and retrieval of programs with direct-to-file operation and built-in Binary program functions.

CRT — Direct view storage CRT.

Alphanumeric — 72 characters per line, 35 lines.

Character Set — Full ASCII including upper/lower case.

Special fonts — Selectable under program control — Swedish, German, British, Spanish, Danish/Norwegian, Graphic, and Business.

Graphic resolution — 1024 x 780 viewable points, 1024 x 1024 addressable points.

Visibility — Flicker-free, easy-on-the-eyes display.

Copier — Compatible with Tektronix 4631 Hard Copy Units.

ORDERING INFORMATION

4052 Desktop Computer System . . . $10,950

Option 24 64K bytes total memory . . . . . Add $2000

OEM terms available on these products.

4054 Desktop Computer

19 inch, High Resolution Display

Dynamic Graphics (option)

Expandable Memory

Enhanced Graphics

GPIB Product

The 4054 is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Control, Talk, Listen.

Unequalled graphics and powerful, fast computing in an integrated desktop computer. The 4054 is the only desktop computer that combines easy-to-learn, extended BASIC with the unique features of a large-screen, high resolution Tektronix display. For rapid calculation, the 4054 has a fast processor with microcoded floating point. The state-of-the-art graphics capabilities of the 4054 provide demand hard copy on any combination of text and high density graphics (with optional hard copy unit). Fast processing coupled with simultaneous text and graphics display offer an excellent fit for many sophisticated graphics environments. In addition, the 4054's memory capacity can be expanded from a standard 32K bytes, to 64K bytes.

Tektronix offers maintenance training classes and user application workshops on the 4050 Graphic System Series. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

The 4054 has a long list of proven peripheral products GPIB (General Purpose Interface Bus) and RS-232-C interfacing coupled with easy-to-program BASIC I/O commands allow considerable versatility in designing your own system.

The 4054 features software compatibility with the rest of the 4050 Series of desktop computers. Programs developed on the 4051 and 4052 will operate on the 4054, giving 4054 users access to a wealth of PLOT 50 software, already written and debugged, thus reducing program development costs often associated with new systems.

The Dynamic Graphics Option adds increased interactivity to the graphics of the 4054 Desktop Computer.

Dynamic Graphics brings the user closer to the solution by providing the graphic power to work directly with the graphic elements of the design problem. Complicated displays can be constructed quickly and easily with movable user-defined objects.

Superior graphic and alphanumeric display. The 4054 with 4096 (x) and 3125 (y) resolution — 13 million addressable points — has all the graphics capability you will need for even the most complex display. With stroke-generated characters programmable in four sizes and eight fonts, the 4054 has the tools to alphanumerically dress up your output to suit any professional requirment. The large screen permits previewing of 132 column line printer output.

For your graphing needs there are 36 distinct dot-dash patterns, selectable under program control, providing for maximum effect of represented data. For interaction the 4054 has a thumbwheel driven, true crosshair cursor. All of these features are implemented using the extended BASIC of the 4054.

Friendly extended BASIC provides the simplicity desired for the beginner together with the flexibility and power required by the experienced programmer. Device independent keywords make program and data input/output operations easy either binary or ASCII formats. Fast, built-in BASIC functions such as SINE, LOG, SQR, etc., plus a complete set of matrix functions provide powerful computation at your fingertips.

SPECIFICATIONS

Processor — LSI bi-polar 16 bit, same as 4052.

Keyboard — Indentical to 4052 keyboard but includes added thumbwheels which control crosshair cursor.

Tape Drive — Identical to 4052.

CRT — Direct view storage CRT.

Alphanumerics — Four program selectable formats.
72 characters per line with 35 lines per display.
79 characters per line with 38 lines per display.
119 characters per line with 58 lines per display.
132 characters per line with 64 lines per display.

Character set — Full ASCII, upper/lower case, high quality, stroke generated characters.

Special fonts — Selectable under program control-Swedish, German, British, Spanish, Danish/Norwegian, Graphic and Business.

Graphics — Vector drawing time - 15k cm/sec.

Addressable resolution — 4096 (x) by 3125 (y).
Dot-dashed vectors, programmable in 36 visibly distinct patterns.
Crosshair cursor with built-in thumbwheels for interactivity.

Visibility — Flicker-free, easy-on-the-eyes display.

Copier — Compatible with Tektronix 4631 Hard Copy Unit.

ORDERING INFORMATION

4054 Desktop Computer $18,100

Option 24 64K bytes total memory $2000

Option 30 Dynamic Graphics $3250

OEM terms available on these products.

Desktop Computer ROM Packs and Options

4051R01
Matrix Functions ROM Pack
(4051 only)

Provides fast matrix manipulation. Multiply, Inverse, Transpose, Identity and Determinant functions. Up to 8.5 times faster with a typical 10 x 10 matrix than equivalent BASIC routines. Useful for solving systems of linear equations, performing 2-D or 3-D transformations, operations research, forecasting, statistics or probability analysis. Built-in on 4052 and 4054.
Order 4051R01 . . . . . $375

4051R05
Binary Program Loader ROM Pack
(4051 only)

Allows storage and retrieval of programs on internal and external magnetic tape in binary format with speed increases up to 4-6 times over the equivalent ASCII operations. Adds LINK function for fast program overlaying in binary format, leaving all variables and their values intact. Built-in on 4052 and 4054.
Order 4051R05 . . . . . $225

4051R06
Editor ROM Pack
(4051 only)

Allows general ASCII file editing of data or programs or text (including FORTRAN, BASIC and COBOL programs) offline. Includes 29 commands such as COPY, INSERT, MOVE, SEARCH and SORT for creating, manipulating and storing ASCII text.
Order 4051R06 . . . . . $650

4052R06
Editor ROM Pack
(4052 and 4054 only)

Same capability as 4051R06.
Order 4052R06 or 4054R06 . . . . . $650

4051R07
Signal Processing ROM Pack #1
(4051 only)

Adds seven new functions which can be applied to one dimensional data arrays; integration, differentiation (2 and 3 point), fast graphing, locating minimum and maximum, and crossing over a threshold. Functions operate 2-10 times faster than equivalent BASIC routines.
Order 4051R07 . . . . . $350

4052R07
Signal Processing ROM Pack #1
(4052 and 4054 only)

Same capability as 4051R07.
Order 4052R07 or 4054R07 . . . . . $350

4051R08
Signal Processing ROM Pack #2
(4051 only)

Extends array handling capabilities by adding commands that perform Fast Fourier Transform (FFT), its inverse (IFT), convolution, correlation, windowing and related utility functions. Functions execute 7-20 times faster than BASIC routines.
Order 4051R08 . . . . . $700

4052R08
Signal Processing ROM Pack #2
(4052 and 4054 only)

Same capability as 4051R08.
Order 4052R08 . . . . . $700

4052R09
Real Time Clock ROM Pack
(4052 and 4054 only)

Provides five time related functions for date and timekeeping, elapsed time measurement and a time programmable 4050 BASIC level interrupt. All functions may be executed directly from the keyboard or may be used within a program.
Order 4052R09 . . . . . $500

4051E01
ROM Expander (4051 only)

Permits connecting up to eight ROM Packs to the 4051. Utilizes one slot of existing two slot backpack.
Order 4051E01 . . . . . $850

Option 01
Data Communications Interface
(4051, 4052 and 4054)

Allows asynchronous bit serial communications between 4050 Series desktop computer and any external device conforming to EIA RS-232 standard. Ease of use is facilitated by a special overlay and added language commands that make communication parameters and communications programmable.
Order Option 01 . . . . . $1400

Option 02
Backpack (4052 and 4054 only)

Optional four-slot backpack.
Order Option 02 . . . . . $400

Option 03
Backpack (4052 and 4054 only)

Optional four-slot backpack with Option 01 Data Communications Interface built-in.
Order Option 03 . . . . . $1700

Option 10
Printer Output Interface
(4051, 4052 and 4054)

Enables 4050 Series system to output alphanumerics to any printer or output device conforming to the RS-232-C or RS-244A Standard for EIA Numerical Machine Control. Data rates are switch-selectable to 50, 75, 134.5, 110, 150, 200, 300, 600, 1200, 4800, 9600 or 16x external clocking. (**Note:** 9600 data rate not available with 4051.)
Order Option 10 . . . . . $550

Option 30
Dynamic Graphics
(4054 only)

Permits complex graphic objects to be created, saved, and recalled with simple BASIC language commands. These objects, saved in a Dynamic Graphics memory can be displayed, blinked, moved anywhere on the screen, and removed without affecting the rest of the display.
Order Option 30 . . . . . $3250

PLOT 50 Graphics Software Library

PLOT 50 software supports the 4050 Series Desktop Computing Systems. The PLOT 50 software provides flexible, interactive programs that aid the user in scientific, engineering and management applications through easy-to-use high quality graphics.

MATHEMATICS VOLUMES 1 & 2

Volume 1 (23 programs) and Volume 2 (16 programs) consist of routines that provide fast solutions to frequently encountered mathematical problems. Included are function analyses, conversions, integration, differentiation, linear programming, and Fast Fourier Transforms. The math volumes can be purchased separately or together at discount as the Math Library.

STATISTICS

The statistics software includes four tape cartridge-based products (statistics Volumes 1-4) and three disk-based products. These packages represent a well-rounded portfolio of statistics routines, from simple descriptive statistics to multiple linear regressions. The 4050DXX Series of statistics software has been enhanced with a special user interface to make the use of statistics extremely easy in your problem solving.

Functions include small samples analysis, analysis of variance and co-variance, polynomiac and multiple linear regressions, and sophisticated non-linear regression techniques. A key feature of the packages is the use of graphics to better understand the nature of the data.

The statistics packages may be purchased separately or at discount as the Statistics Library.

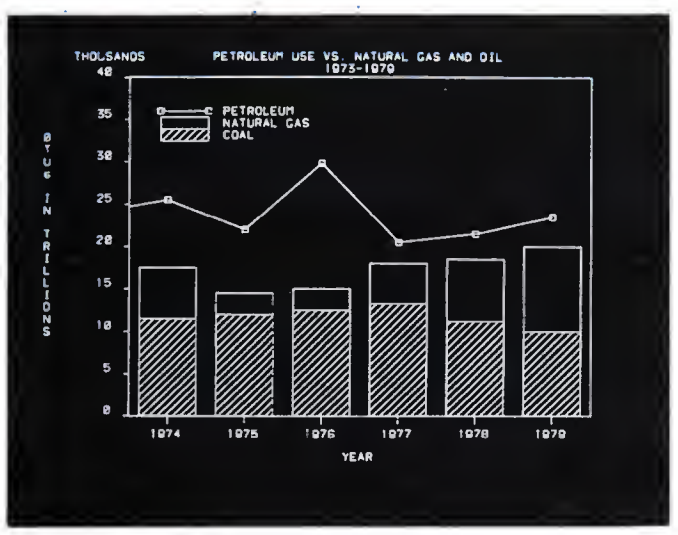
MANAGEMENT GRAPHICS

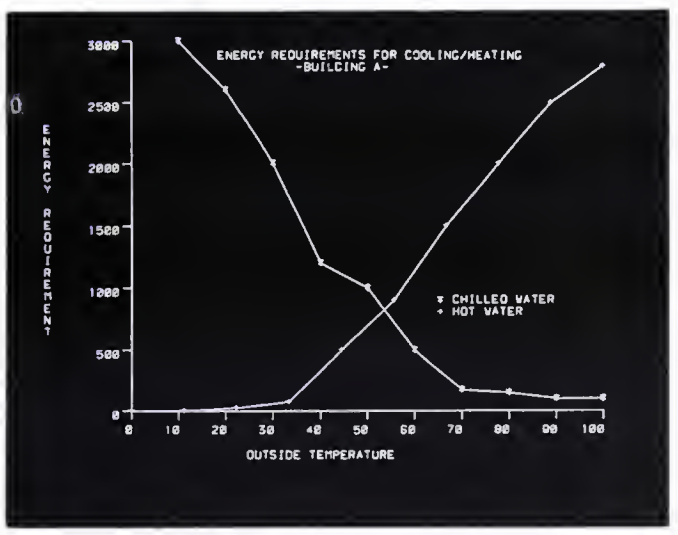
Business and technical managers are supported by a number of flexible graphing packages. Business Planning and Analysis Volume 1 & 2 provide programs for basic decision making, such as Break-Even Analysis, to Time Series Analysis and Forecasting. Modeling and Reporting Software (MARS) is a general purpose modeling package that allows the user to automate the reporting processes. Data is entered, stored, and manipulated in matrix format. Presentation Aids are oriented towards the easy generation of overhead transparencies, both graphic and textual.

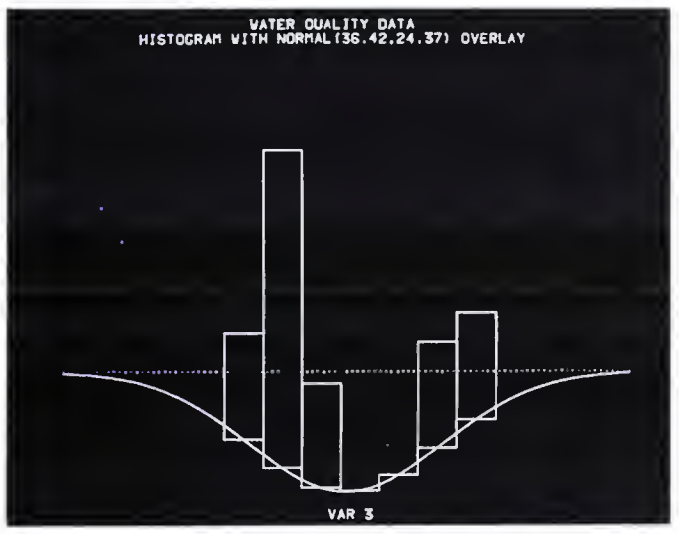
OTHER PLOT 50 PRODUCTS

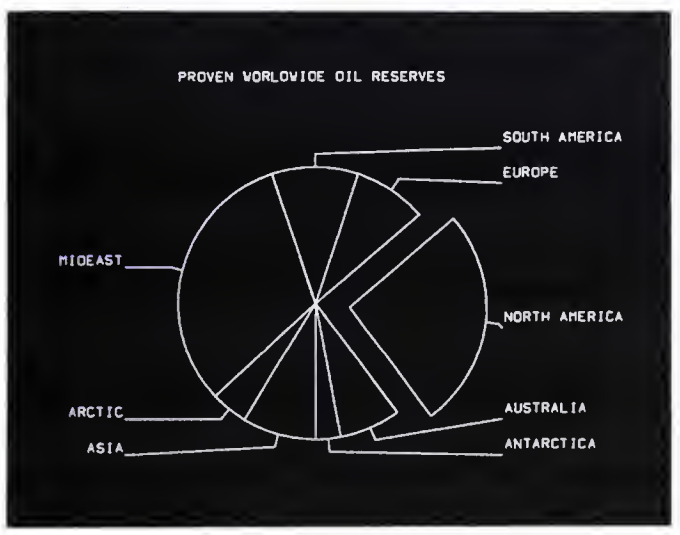
Picture Composition allows the user to create simple or complex drawings from a tablet without being a programming expert. Graph plot provides the user with multiple graphs per page. General utilities provide subroutines for editing, duplicating, and sorting. Digitizing provides editing and computation support during graphic input. And there's more.

Tektronix offers OEM Software Licensing Agreements. See your Tektronix OEM representative for full details.









Digital Plotter

4662 Interactive Digital Plotter

Intelligent B-size (A3) Plotter

Multi-color Capability

Built-In RS-232 and GPIB Interface

GPIB Product

GPIB Peripheral

The 4662 is the first plotter with built-in processing power. As such it has the capability to work on its own, without bogging down computational operations. Studded with state-of-the-art technology, it works with an accuracy and repeatability that no other plotter can approach for the price.

From the moment you turn it on, you can tell the difference: the 4662 automatically adjusts for 254 mm x 391 mm (10" x 15") plot. There's no need to worry how the last plot was set up. When you wish to set a different plotting area or adjust to a new paper size, you simply use the SET control buttons on the front panel to define the new area. The 4662 plots on paper, vellum, mylar, acetate-film and preprinted forms.

Once it starts moving, you really notice the improvement over other plotters: the 4662's digital stepping motors and internal vector generator work at high speed, with microprocessor-controlled acceleration and deceleration.

Repeatability is excellent, time after time. There is no servo hysteresis, no drift as in potentiometric feedback systems. And no slidewires to clean, no moving electrical contacts, no servo adjustments to be made.

It's a better kind of plotter with a competitive price for which Tektronix is famous.

The complete plotter. The 4662 is not only easy to talk to; it has a great memory. Input data is internally buffered so you can optimize data transfer from your host processor, or move on to your next computation while the 4662 is plotting.

Up to four 4662's can be teamed up in series, and up to 15 4662's can be used with one GPIB device like the Tektronix 4050 Series of desktop graphic computers. Each plotter can perform its own job simultaneously while the host processor turns to other tasks. A simple, unique code activates each plotter.

Digitizing on any compatible graphic terminal or host system is easy with the 4662's built-in joystick control. Move the pen to the desired position on the plot, press the CALL key, and the plotter sends the x-y data points to the system. A GIN command causes the plotter to send the current x-y pen coordinates and pen up, pen down information. If the pen is outside the page boundaries, boundary values are sent and a bell on the plotter signals the operator.

The 4662's internal alphanumeric character generator produces a full upper-lower case ASCII character set. You can request alphanumerics of any height and width. Selected characters are available in seven different standard fonts. In addition, interchangeable pens and pen types offer multicolor and multiline width capability.

Plot from any point of view. Not only is character scaling possible, but alphanumerics can just as rapidly be rotated in 1° or finer increments. Drawing speed is generally as fast or faster than any other plotter in the 4662's price range. Both RS-232 and GPIB interfaces are standard at no extra cost.

Contact your local Tektronix Sales Engineer for more information on this easy-to-use, exceptional B-size plotter.

SPECIFICATIONS

Plotting area — X-Axis greater than 15 in (381 mm).
Y-Axis greater than 10 in (254 mm).

Repeatability — ± 0.0025 in (± 0.06 mm).

Time to maximum velocity — Approx. 120 mm/s.

Resolution — 0.005 in (0.127 mm).

Plotting rate — 16-22 ips (40.6-55.9 mm/s) vector dependent.

Point plotting rate — Pen action rate 10 points/s max.

Character set — Full ASCII character set.

Pen control — By software control or by operation of front panel PEN button. Pen may be disabled manually.

Position controls — Joystick vector rates variable from 0.015 ips to 4 ips.

Writing method — Nylon-tipped pen or wet ink drafting pen.

Paper size — 11 x 17 in (279 mm x 432 mm) maximum.

Paper retainer — Electrostatic hold-down.

Drive characteristics — Two four-phase stepping motors, each operating a pulley/cable system to propel the pen in that motor's respective axis.

GPIB — Conforms to IEEE Standard 488-1978.

ORDERING INFORMATION

4662 Interactive Digital Plotter $4600

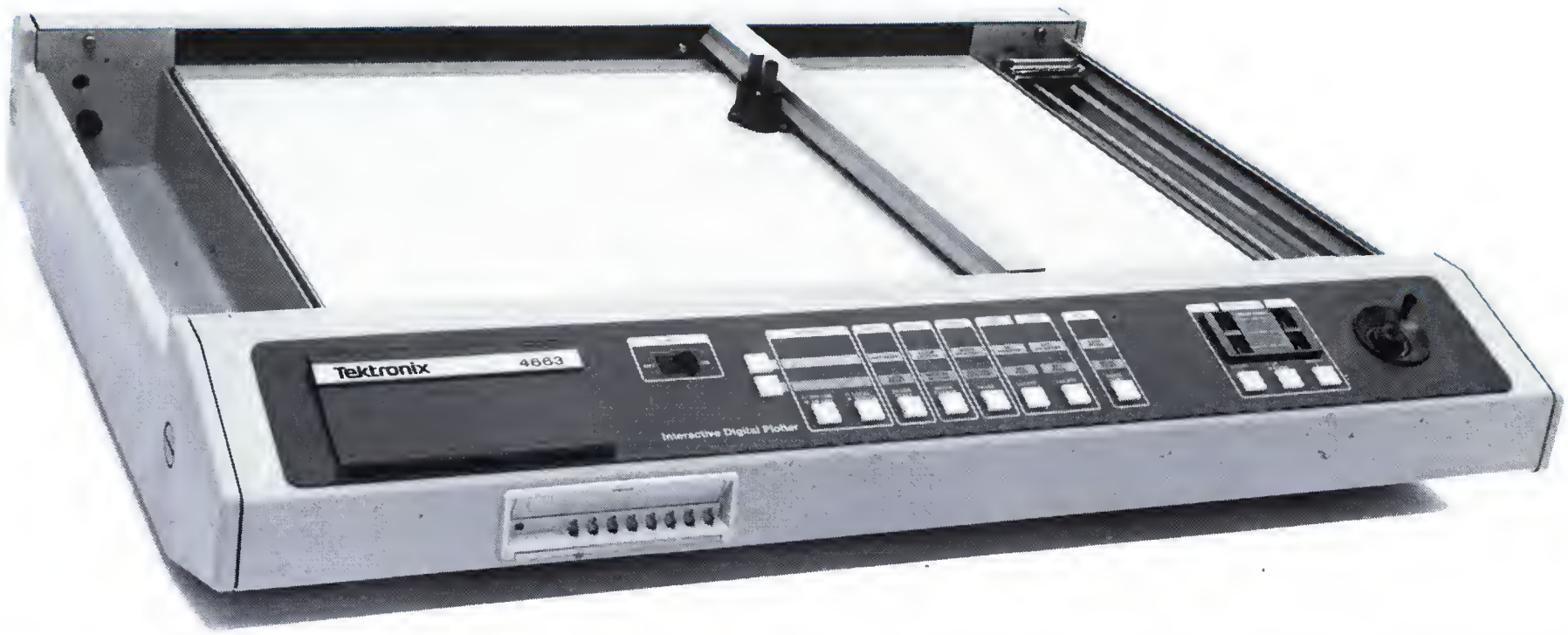
Option 01 — GPIB I/F cable instead of RS-232-C I/F cable . . . . . No Charge
Option 30-RS-232-C (4081 only) . . . . . Add $600

4662A01 PLOT 10 Utility routines software $420

Drafting vellum (17 in x 22 in), order 006-2836-00 (100 sheets) $30

Mylar sheets (17 in x 22 in), order 006-2835-00 (100 sheets) $100

OEM terms available on these products.



4663 Interactive Digital Plotter

- Intelligent C-Size (A2) plotter
- Dual programmable pen control
- Nine character fonts
- RS-232 and GPIB product

GPIB Peripheral

Finally: An intelligent plotter that saves time without sacrificing flexibility. The 4663 is the first high speed C-size plotter with built-in processing power and 5.5K buffer memory to free the host from many routine computational operations. But the 4663 story isn't just the intelligence, but how intelligently it has been put to use.

The 4663 can handle either 420 mm x 594 mm (European A-2 drafting size) or 432 mm x 559 mm (American C size — 17" x 22") paper, mylar or acetate with felt tip, liquid ball, or wet ink pens to give you crisp, clean camera-ready copies or overhead transparencies.

A paper advance option is available for roll stock, with form feed remotely or locally programmable. This option allows the 4663 to operate unattended with a variety of form sizes.

Tektronix offers maintenance training classes on the 4663 Interactive Digital Plotter. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

The plotter features dual programmable pen control with interchangeable multicolor pens and is capable of producing dotted or dashed lines from local firmware. Built-in joystick allows easy manual positioning of the pens for digitizing or page scaling adjustments.

Features like these make the 4663 a natural for printed circuit board manufacturing and metal working applications or civil engineering and drafting environments including CalComp previewing and mapping.

Unique parameter entry device. This front panel card device lets you quickly identify or select operating parameters without resorting to binary switches, straps, status display devices, and volumes of operator manuals. It allows you to quickly program baud rate, pen type, acceleration, plotting speed, aspect ratio, page size and many other parameters.

These parameters can be stored up to 90 days without power. Up to four users can configure the plotter to their individual requirements with Option 37.

Excellent penmanship. Nine character fonts come standard with the 4663, including the full ASCII character set. All characters can be scaled, slanted, rotated and may be centered when used as plot symbols.

Several other performance options are offered such as downloadable character sets, and programmable macros. Arc and circle generation capability, utilizing circular interpolation, is also available. Standard fixed macros allow the current viewport to be outlined or an axis drawn.

Local functions. Various graphic functions are implemented via firmware. Page scaling, windowing, viewporting and clipping are typical.

Hardware loop through RS-232-C interface is standard and optional interfaces include GPIB, TTY and 20/60 mA current loop.

Graphing software support. Tektronix PLOT 10 Utility Routines for the 4663 control the plotter's multiple pens, paper advance, and built-in arc and circle generation. They also control selection of built-in character fonts. The 4663 is also compatible via GPIB with the 4050 Series of desktop computers using BASIC language keywords to provide similar controls.

SPECIFICATIONS

Max Plotting Area — X axis-22.4 in (569 mm). Y axis-17 in (432 mm).

Repeatability — ± 0.001 in (.025 mm).

Max. Plotting Speed — 16-22 ips (406-559 mm) Vector dependent.

Point Plotting Rate — 10 pts per sec. max.

Character Generator — 95 ASCII, 15 x 7 Matrix, 7 Special Fonts Std.

Paper Size — U.S. C-Size 17 in x 22 in. European A2 Size (420 mm x 594 mm).

Paper Retention — Electrostatic hold down, sprocket feed paper advance (Optional).

Media Types — Paper or Mylar.

Drive Characteristics — Microprocessor controlled stepping motors controlling cable system connected to pen arm.

Baud Rate — 110-9600 baud.

Standard Interface — RS-232-C, full duplex, Loop-through.

ORDERING INFORMATION

4663 Interactive Digital Plotter	**$11,000**
Option 01-GPIB I/F cable (deletes RS-232-C)	Add $425
Option 04-GPIB only (deletes RS-232-C)	No Charge
Option 30-RS-232-C (4081 only)	Add $600
Option 31-Circular interpolation and programmable macros	Add $525
Option 32-Math character set and down leadable characters	Add $450
Option 36-Paper advance	Add $800
Option 37-Added default parameters	Add $275
4663A01 PLOT 10 Utility Routines software	**$665**
Drafting vellum (17 in x 22 in), 006-2836-00 (100 sheets)	$30
Mylar sheets (17 in x 22 in) 006-2835-00 (100 sheets)	$100
Dust Cover — Soft vinyl, 200-2392-00	$20

OEM terms available on these products.

Hard Copy Units

Hard Copy Devices

Quick and convenient copies of complex information displayed on a screen are essential to the use of graphic terminals, desktop computing systems, and video image processing systems. Graphic and alphanumeric information is recorded on paper at the press of a button, to fulfill a variety of user needs. These include the need for quick preview copy before final plotting, and copies of intermediate steps during interactive work sessions. Just as important are permanent records of results for the file, and final output of high quality for use in reports and presentations. Tektronix offers three display copying devices to cover all of these hard copy needs.

Within the product family one device for copying storage tube screens, and two for copying general video devices such as raster scan terminals, video cameras and monitors, or image processing systems. Tektronix' own implementation of fiber optic technology is provided in the 4631 for storage tube copy, and in the 4632 and 4634 for video imaging copy. See pages 59 and 70 for more information.

Fiber optics, based on photosensitive (light exposure) techniques, gives the highest quality hard copy for dense and complex graphic displays.

The concept of these alternative family offerings is to fulfill a variety of hard copy requirements — whether the need is for low-cost black and white terminal copy, or for high resolution gray shaded copy from a sophisticated image processing system.

PRODUCT		TECHNOLOGY	DESIGNED FOR
4631	Hard Copy Unit	fiber optic	storage tube displays
4632	Video Hard Copy Unit	fiber optic	raster scan terminals/video signal sources
4634	Imaging Hard Copy Unit	fiber optic	raster scan/video image processing systems

Tektronix offers maintenance training classes on Hard Copy Units and the terminals they support. For further training information, contact your local Field Office or request a copy of the Customer Training Catalog on the return card at the back of this catalog.

4631 Hard Copy Unit

High Image Quality

Copies in Seconds

Fiber Optic Process

Storage Tube Compatible

The 4631 provides permanent, dry copies of any graphic and alphanumeric information displayed on the storage tube screen. The 4631's fiber optic process uses dry silver paper for the fine detail and photographic quality image needed when copying complex graphics and alphanumerics. The 4631 requires no toners or chemical additives of any kind. The entire process is clean and safe, as images are created using only light and heat.

The 4631 is a tabletop unit, easy to move wherever needed. As a special convenience, the 4631 automatically cuts and stacks all copies into its built-in tray. A four-digit copy counter is an optional feature.

Copies can be made in either vertical or horizontal format. The copy time is 18 seconds for the first copy and only 10 seconds for subsequent copies of the same display. A special "slow scanning" mode allows images on the horizontal format to be made at even higher resolution and image quality.

The 4631 can be multiplexed to copy up to four storage tube terminals and/or display monitors. It is compatible with the 4010 Series of computer display terminals, the 4025 terminal, the 4050 Series of graphic computing systems, and the 4081 interactive graphics terminal. The 4631 is also compatible with Tektronix 11" and 19" computer display modules.

SPECIFICATIONS

Weight — 65 lb.

Paper size — 8.5 in. x 11 in. (216 mm x 277 mm)

Image size — 8.85 in. x 6.7 in. (225 mm x 170 mm), horizontal format
7.1 in. x 5.4 in. (180 mm x 137 mm), vertical format

Copy time — 18 seconds first copy (36 seconds in special scan mode)
8 seconds subsequent copies (17 seconds in special scan mode)

Warmup Time — 10 min.

Addressability — 200 dots per inch, horizontal
171 dots per inch, vertical

Paper — standard dry-silver, 500 ft. per roll

ORDERING INFORMATION

4631 Hard Copy Unit $4,950

Option 02 Four-Channel Multiplexer . . . . . Add $600
Option 31 Compatible with the 4025 Terminal . . No Charge
Option 48 220 V, 50 Hz . . . . . No Charge

Supplies

Paper — one roll, order 006-1603-00 . . . . . $70.00
Paper — one case of four rolls, order 006-1603-01 . . . . . 240.00

OEM terms available on these products.

4632 Video Hard Copy Unit

- High Image Quality
- Gray Scale Capability
- Copies in Seconds
- Video Source Compatible

The 4632 provides permanent copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. The 4632's fiber optic process is clean and safe, as images are created using only light and heat.

The 4632 is a tabletop unit, easy to move wherever needed. As a special convenience, the 4632 automatically cuts and stacks all copies into its built in tray. A four-digit copy counter is an optional feature. All copies are horizontally oriented. The copy time is 18 seconds for the first copy, and only 8 seconds for subsequent copies of the same display. Eight distinct shades of gray can be copied by the 4632 with a special gray scale enhancement option. The standard 4632 can clearly show six different shades of gray, for polygon fill-in, bar charts, and many other applications.

The 4632 can be multiplexed to copy up to four raster scan terminals, and can accept remote copy signals. The 4632 is compatible with a wide variety of raster scan terminals and video signal sources, including those which produce RS-170, RS-330, RS-375A, RS-343A and RS-412A type signals. The standard 4632 is prepared for use with 525 line, 60 Hz sources. Many other adjustments are provided as options, including adjustments for 625 line, 50 Hz and for high resolution 1029 line, 60 Hz.

SPECIFICATIONS

Weight — 65 lb.
Paper size — 8.5 in. x 11 in. (216 mm x 277 mm)
Image size — 8.4 in. x 6.3 in. (213 mm x 160 mm)
Copy time — 18 seconds first copy
8 seconds subsequent copies
Warmup Time — 10 min.
Addressability — 200 dots per inch, horizontal
171 dots per inch, vertical
Paper — standard dry-silver, 500 ft. per roll

ORDERING INFORMATION

4632 Video Hard Copy Unit	**$4,950**
Option 02 Four-Channel Multiplexer	Add $600
Option 03 Setup for 625 Line, 50 Hz	No Charge
Option 04 Setup for 1029 Line, 60 Hz	No Charge
Option 05 Setup for 4023 Terminal	No Charge
Option 06 Enhanced Gray Scale	Add $500
Option 07 Compatible with HP 2640 Series Terminals	Add $200
Option 08 Compatible with DEC MINC Systems	No Charge
Option 09 Setup for AT&T GEMINI™ 100 Systems	$60.00
Option 48 220 V, 50 Hz	No Charge
Paper — one roll, order 006-1603-00	$70.00
case of four rolls, order 006-1603-01	$240.00

OEM terms available on these products.

Matrix Printers and File Manager

4641 Matrix Printer

Printed output from a thoroughly dependable package. The Tektronix 4641 Matrix Printer lets you command alphanumeric printout quickly and quietly, with complete form and format versatility.

When interfaced with a 4050 Series desktop computer, the 4641 is ready for reliable performance at speeds up to 180 cps, for all kinds of output applications.

A servo-controlled carriage assures precise placement of characters, upper and lower case, on a 7 x 7 dot matrix, 180 characters per line, six lines to the vertical inch. A selectable form feed feature lets you handle a variety of format sizes, from labels to legal.

The printer includes a self-test function that automatically runs through all characters.

Geared for forms. A tractor-driven paper feed system facilitates dependable feeding of multipart forms. The printer will adjust for forms up to 6 parts (0.020 maximum thickness) and in varying widths. Accurate vertical and horizontal character placement is provided.

Format control will adjust machine operation to 11 different form lengths. An alarm signals when paper is exhausted.

The 4641-1 is the 220 V ac, 50 Hz version of the 4641. All options and accessories are identical.

ORDERING INFORMATION

4641 Matrix Printer	**$4,550**
Option 02 4052/4054 Interface	No Charge

4642 Matrix Printer

Fast printer output is yours at low cost with the Tektronix 4642 Matrix Printer. This table top printing unit offers 60 character-per-second output speed, along with a variety of print alternatives. It is compatible with the Tektronix 4020 Series of Computer Display Terminals and 4050 Series of desktop computers. Interface is standard RS-232-C.

A variety of type faces. The 4642 gives the operator a varied selection of upper and lower case type faces. The standard format prints in 80 columns, and provides a choice of regular and elongated characters. A condensed character set, selectable from a front panel switch, gives 132 column output, and again, a choice of regular or elongated characters. Characters are formed on a 5 x 6 dot matrix.

Compact, easy to use. The 4642 requires minimum space for operation. Paper feed is by friction on the standard version, which uses inexpensive roll paper. The optional tractor feed paper drive can be used with both fan-fold paper and multipart forms.

A choice of features. A complete selection of features and accessories can make the 4642 Matrix Printer even more versatile. For example, Option 1, a rear feed tractor paper drive option, allows output of an original and four copies. A printer stand is available to convert the 4642 to a floor unit. The 4642-1 is the 220 V ac, 50 Hz version of the 4642. All options and accessories are identical.

ORDERING INFORMATION

4642 Matrix Printer	**$2350**
Option 01 Rear Feed Tractor Assembly	Add $225

4907 File Manager

The 4907 is a direct access flexible disc device with a double density read/write feature that enables up to 630K bytes capacity per disc.

An advanced multiple level file-by-name system includes a directory that maintains the user files, passwords and available space. For applications requiring additional storage capacity, several drives may be connected to the file manager. Software commands are extensive with this file manager and its compact size is small enough to let it fit on a desktop or lab bench.

Built-in ROMs and special 4050 Series Desktop Computer's ROM Packs contain the 4907 operating system software. No 4050 Series Memory is required to support the operating system. The 4907 can also be used with some of the 4010 Series of graphic terminals.

ORDERING INFORMATION

4907 File Manager	**$4850**
Option 30 Two Disc Drives Total	Add $2700
Option 31 Three Disc Drives Total	Add $4300
Option 40 4052/4054 Interface	No Charge

OEM terms available on these products.

4905 Mass Storage Module

The 4905 provides a medium density, memory storage system designed especially for the 4080 graphics display users.

The 4905 comes with a controller that serves two disc drives. The byte storage facility of the system provides up to 20 million bytes on one 4905 option — yet you can start out with an option which provides 630K bytes of additional storage at extremely reasonable cost.

ORDERING INFORMATION

4905 Mass Storage Module	**$635**
Option 31 Dual Flexible Disc	Add $5725
Option 32 Two Dual Flexible Disc	Add $11,450
Option 33 Single Hard Disc	Add $12,000
Option 34 Dual Hard Disc	Add $21,000

Digital Cartridge Tape Recorder/Drive, Graphic Tablets and Joystick

4923 Digital Cartridge Tape Drive
4924 Recorder GPIB Peripheral

Both digital recorders are highly reliable, very easy to use for data storage and retrieval. They also contain an RS-232-C interface which allows them to support any compatible computer display terminal from 110 to 9600 baud.

Each tape cartridge can store approximately 300K bytes of high density digital data. Files of variable length and files containing variable number of formatted records can be easily stored by these two storage systems.

The 4924 offers a tape fetch feature and terminal interrupt capability and can operate with Tektronix graphics terminals via the terminal IEEE-488 bus. Transfer data rates are 10K baud max. Read data operates at 762 mm/sec (30 inches/sec) and the Fast Forward Mode allows you to skip forward or reverse at 2290 mm/sec (90 inches/sec). Up to 15 tape drives may be multiplexed to any 4050 Series Desktop Graphic Computer at any one time.

ORDERING INFORMATON

4923 Digital Cartridge Tape Recorder $2300
Option 01 RS-232-C ..... No Charge
4924 Digital Cartridge Tape Drive $2695

4953, 4954, 4956 Graphic Tablets

With the 4953/54/56 Graphic Tablets, you can choose one of two input device options: a pen for best convenience, or a push-button cursor where exacting accuracy is required. You can input points or vectors to digitize or display maps, graphic drawings, schematics and other designs.

From precision mapping to exacting parts outlines, Tektronix Graphic Tablets satisfy a wide range of user needs. You can select options from a written "menu" placed on a Graphic Tablet. You can store graphic input on peripheral disc or recorder devices, recall it later, and make quick, dry-process copies on a Tektronix hard copy unit.

And Tektronix offers all of the pieces you'll need with your computer for a truly interactive graphics system. Take your pick of the 279 mm x 279 mm (11" x 11") 4953 model, the drawing board-sized 1016 mm x 762 mm (40" x 30") 4954 model, or the 4956 in two sizes. Standard is 510 mm x 510 mm (20" x 20") and the Option 33 version is 910 mm x 1220 mm (36" x 48"). The latter version is large enough to accommodate E-size engineering drawings. Power modules are compact to help curb desktop clutter for all these graphic tables.

ORDERING INFORMATION

4953 Graphic Tablet 11" x 11" (279 mm x 279 mm) $3475
Option 30 4081 I/F Cable ..... Add $525
Cursor, order 119-0622-00 ..... $235
4954 Graphic Tablet 40" x 30" (1016 mm x 762 mm) $5675
Option 30 4081 I/F Cable ..... Add $525
4954F32 Pedestal $1325
Cursor, order 119-0622-00 ..... $235
4956 Graphic Tablet 20" x 20" (510 mm x 510 mm) $5195
Option 33 Graphic Tablet 36"x48" (910 mm x 1220 mm) ..... Add $2600
Cursor, order 119-0875-00 ..... $300

4952 Joystick

For desktop computer users needing increased interactivity, the 4952 Option 2 Joystick is the last word in fingertip input control. Accurate to 0.1%, the sensitive cursor control activated by the POINTER command lets you quickly position the cursor the first time precisely.

More to build on, less to repair. By entering a command in BASIC the 4952 Joystick will put the pointer on-screen and initiate movement. Drift is negligible.

The 4952 is simplicity itself. Just move the center lever in the direction you want to move the cursor; speed is controlled by the angle and distance of the lever from the center position. And when you want to stop the cursor, simply release the lever to its natural vertical position.

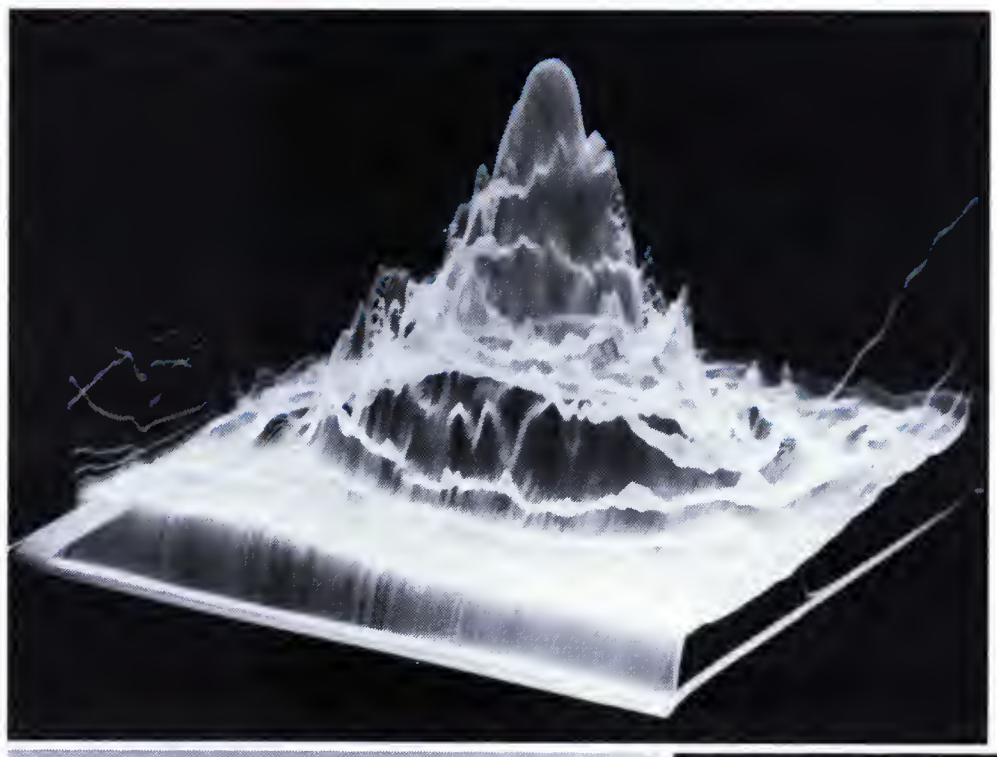
Compatibility for the Joystick is assured with all terminals in our 4010 family, 4081 Interactive Graphic Systems and 4050 Series Desktop Computers.

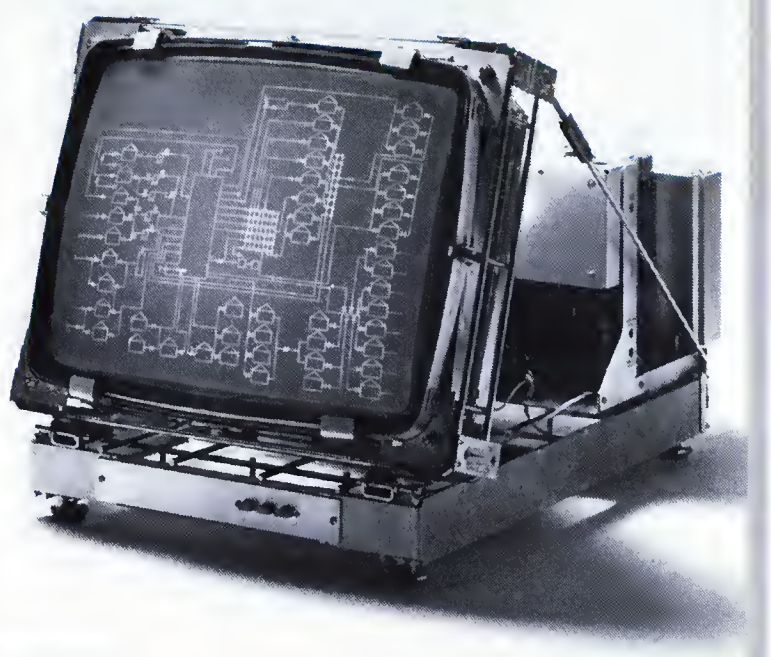
ORDERING INFORMATION

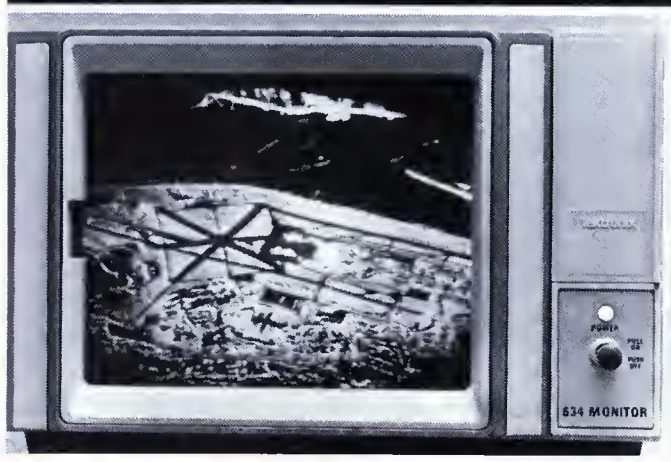
4952 Joystick (4014/4015) $525
Option 01 Joystick (4010, 4012/4013) ..... Add $75
Option 02 Joystick (4050 Series) ..... Add $100

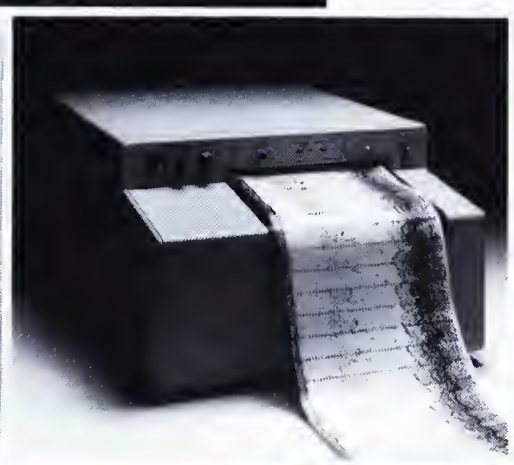
OEM terms available on these products.

OEM Imaging Products









The Tektronix OEM Commitment

Reliability. Performance. Value. Support.

When you deal with Tektronix, you're dealing with a supplier who stands behind you every step of the way. As a world leader in display technology, we're committed to building lasting OEM relationships and supporting them with continuing new product developments.

Your Tektronix resource starts with a broad and comprehensive package of OEM support: OEM pricing, terms and conditions to help make you competitive. OEM service agreements and service capability throughout the United States and in many countries. Applications engineering including interface assistance, custom mods, documentation, software compatibility, and much more.

At Tektronix, our product reliability is your foundation. Your systems can only be as reliable as the components that go into them. At Tektronix, we're committed to producing the most dependable components possible. You can be confident that the reliability we engineer into every component can help keep your customers satisfied and your service costs down. That's quality you can bank on.

Leadership in systems must begin with leadership in components. Explore the advantages to working with Tektronix: excellence in products, in OEM support, and service. Your local Tektronix OEM Representative can give you full details on how you can profit from a partnership with Tektronix.

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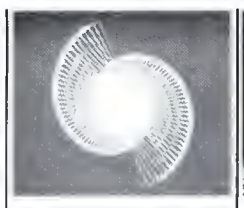
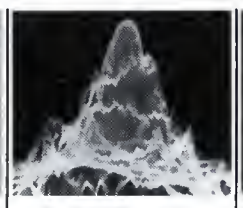
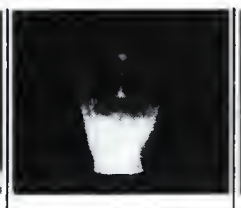
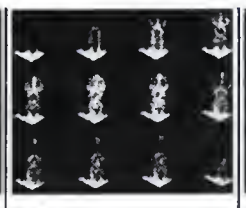
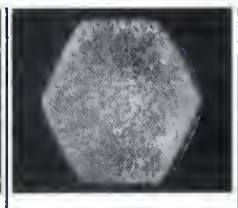
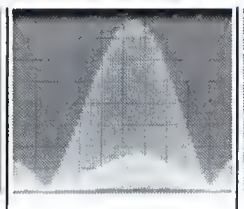
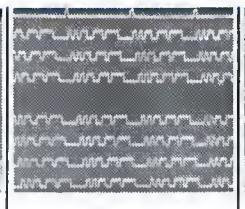
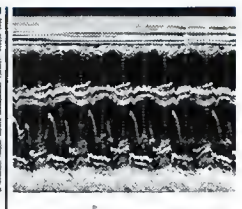
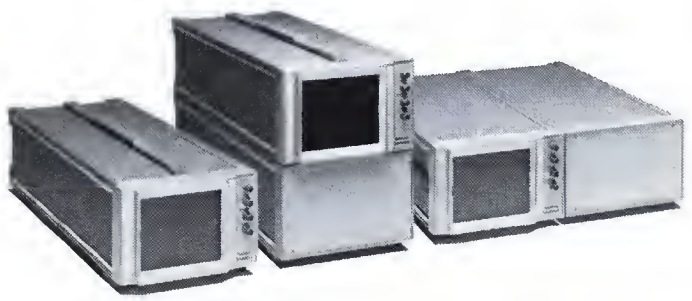
KEY SPECIFICATIONS FOR X-Y DISPLAYS

See your local Tektronix representative for complete specifications, options and ordering information, or use the return card.

	 603A	 604A	 606A	 606B	 607A	 608	 620	 624
Spot Size[1]	0.25 mm (10 mils)	0.36 mm (14 mils)	0.13 mm (5 mils)	0.08 mm (3.1 mils)	0.25 mm (10 mils)	0.26 mm (10 mils)	<15 mil, <25 mil at max drive	0.30 mm (12 mils)
Display Size	10.2 x 12.7 cm	10.2 x 12.7 cm	8 x 10 cm	8 x 10 cm	7.2 x 9 cm	9.8 x 12.2 cm	10 x 12 cm	9.8 x 12.2 cm
Acceleration Potential	3.5 kV	3.5 kV	5.6 kV	5.5 kV	12 kV	22.5 kV	12 kV	≈18 kV
Bandwidth, X-Y[2]	≥2 MHz	≥2 MHz	≥3 MHz	>3 MHz	≥3 MHz	≥5 MHz	≥2 MHz	≥3 MHz
Bandwidth, Z[2]	≥5 MHz	≥5 MHz	≥10 MHz	5 MHz	≥5 MHz	≥10 MHz	≥5 MHz	≥5 MHz
Rise Time	≤70 ns	≤70 ns	≤35 ns	<35 ns	≤70 ns	≤35 ns		≤70 ns
Input R and C, X-Y[3]	1 MΩ ±1% || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ ±1% or 50 Ω || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ, || ≤60 pF	1 MΩ || 47 pF	1 MΩ || <47 pF
Input R and C, Z[3]	1 MΩ || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ <47 pF	1 MΩ or 5 MΩ	1 MΩ <47 pF	1 MΩ, ≤60 pF	1 MΩ <47 pF	1 MΩ || <47 pF
X-Y Phase Difference	≤1° to 500 kHz	≤1° to ≤500 V	<1° to 500 kHz	1° to ≥500 kHz	≤1° to 500 kHz	≤1° to 1.5 MHz	≤1° dc to 500 kHz	<1° to 1.0 MHz
Recommended Source Impedance, X-Y and Z	≤10 kΩ	≤10 kΩ	≤10 kΩ	<10 Ω in 1 Ω pos.	≤10 kΩ	≤10 kΩ	≤10 kΩ	≤10 kΩ
Temperature Range	0°C to +50°C	0°C to +50°C	0°C to +50°C	0° to 50°C	0°C to +50°C	0°C to +50°C	0°C to +50°C	0°C to +50°C
Power Requirements[4]	75 W	56 W	75 W	75 W	53 W	61 W	See footnote[4]	61 W
Included Accessories	External program connector; connector cover; external graticule	External program connector; connector cover.	External graticule		External program connector; connector cover; external graticule.	Lined external implosion shield (graticule) for adjustment purposes.	Lined external implosion shield (graticule) for adjustment purposes.	
Recommended Cameras[5]	C-59A, C-5C C-5C Opt. 01, C-28	C-59A, C-5C Opt. 01, C-28	C-28, C-5C Opt. 01, C-59A	C-28, C-30BP	C-5C, C-5C Opt. 01, C-28	C-5C, C-59A, C-28	C-5C, C-5C Opt. 01, C-28	C-5C, C-28

1. Measured at 0.5 μA, except for the 606A, measured at 0.1 μA.
2. Full spec would read: "dc to . . ." appropriate figure.
3. "|| <" means "paralleled by less than".
4. Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V (±10% on each range). 48 to 440 Hz (except the 624 which excludes 220). Number given shows watt max at nominal line voltage. The 620's power requirements are 90-132 V ac; 48-440 Hz line frequency, 22 W max, 0.2A at 120 V ac 60 Hz.
5. External 15 V dc 750 mA power supply required for C-28.

The standard displays come without a handle, feet or covers. See your local Tektronix Representative for complete specifications, options and ordering information, or use the return card.



MODULAR PACKAGING AND RACK MOUNTING

PACKAGING FOR THE 620

Vertical dress package. Includes handle, feet and covers.
Order 016-0409-00 .....**$175**

Horizontal dress package. Includes handle, feet and covers.
Order 016-0410-00 .....**$175**

Rackmount kits for the 620.
Slide-out 19″ rack assembly which rackmounts one 620 and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and combine it with the display. Includes frame, covers and rack slides. Not available with Options 06, 23, 28.
Order 016-0404-00 .....**$195**

Slide-out 19″ rack assembly which rackmounts two 620s side by side. Includes covers and rack slides. Not available with Options 06, 23, 28, 31.
Order 016-0405-00 .....**$175**

Small-width packaging. Smaller-width packaging removes controls (intensity, focus, spot position) from the right side of the crt. Allows OEM to mount elsewhere in this system. Request quote from your Tektronix representative.

RACKMOUNTING FOR 603A, 604A, 606A, 606B, 607A, 608, 624

Rackmount and Empty Cabinet Kit for 603A, 604A, 606A, 606B, 607A, 608, and 624. Slide-out 19″ rack assembly which mounts a display monitor and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and connect it to the display, all in one enclosure.
Order 040-0601-00 .....**$175**

Display/Power Module Kit. Allows rackmounting of 603A, 604A, 606A, 606B, 607A, 608, and 624 with TM 503 Power Module. Minimizes mechanical design time. Simply design your own electronics using TM 500 Custom Plug-in kits described on p. 220. Then plug them in. Fits standard 19″ rack.
Order 040-0624-01 .....**$90**

Rackmounting kit for 603A, 604A, 606A, 606B, 607A, 608, and 624.
Slide-out 19″ rack assembly which rackmounts any two of the above displays side by side. Includes covers and rack slides.
Order 040-0600-00 .....**$135**

Rackmount-to-Cabinet Conversion, required to convert a rackmount 603A, 604A, 606A, 606B, 607A, 608 and 624 to a cabinet style.
Order 040-0602-00 .....**$125**

Key specifications for 634 video display

Video Display		634	634 Opt. 01
Resolution *	Worst case	1100 line	650 line
	Nominal	1400 line	800 line
Display Size		9x12 cm (flat screen)	
Position Accuracy/ Non-Linearity		≤0.5% within 9 cm circle, ≤1% in corners. For Option 01: 1% within 9 cm circle, 2% at corners.	
Brightness		515 cd/m² (150 fL) max.	
Brightness Non-uniformity		Less than ±10%	
Bandwidth		1 Hz-10 MHz std. 20 MHz Video bandwidth available as Option 14.	

Note: Standard 634 accepts the line/field rate of 625/50. Discrete line rates of 675/60 through 1083/60 can be accommodated using option 15.
*Merged raster lines.

Recommended Cameras: C-5C, C28[7].

Applications For Selected OEM Imaging Products

Recommended Display	Medical Instrumentation	Electronic Test Equipment	Defense Electronics	Analytical Instrumentation
634 Very High Resolution Video Display	Ultrasound raster scan Computerized tomography Multi-imaging cameras	High-density graphics, alphanumerics and imaging	Reconnaissance & surveillance Target acquisition FLIR LLLTV	Electron microscopy
606B Very High Resolution X-Y Display	Nuclear multi-imaging Gamma camera Ultrasound multi-imaging	High-density graphics alphanumerics and imaging	Imaging for scan conversion	Scanning electron microscopy Micro probe Radiation and thermal scanning
606A High Resolution X-Y Display	Nuclear multi-imaging Gamma camera Ultrasound multi-imaging	High-density graphics, alphanumerics and imaging	Imaging for scan conversion	Scanning electron microscopy
608 High Brightness X-Y Display	Ultrasound: M-Mode Real time Sector scan B-scan	Spectrum analysis	Navigation and control Automated test systems Simulators IR imaging	Mass Spectrometry Nondestructive testing NMR FTIR
620 General Purpose X-Y Display	Ultrasound: A-mode Physiological measurements	Logic analyzers Automated test equipment Spectrum analysis RF-sweepers TV waveform monitor	Electronic counter-measures Radar-A scopes Sonar PPI	Nondestructive testing Multi-channel pulse height analyzers
607A Variable Persistence Storage X-Y Display	Gamma camera Ultrasound: M-mode ECG EKG	Transient analysis Automated test equipment Spectrum analysis	Navigation and control Electronic counter-measures Automated test equipment Target acquisition	Scanning electron microscopy NMR Mass spectrometry
603A Bistable Storage X-Y Display	Physiological measurements	Transient analysis Spectrum analysis Graphics and alphanumerics	Direction finding Spectrum analysis	Mechanical shock testing Seismic analysis Strain gauge measurement Nondestructive testing

High Resolution Video Display and General Purpose Waveform Display

634

High Resolution Video Display for critical applications (1400 lines, shrinking raster)

<½% Linearity Inside the 9 cm Quality Area

Excellent Gray Scale and Brightness Uniformity

The 634 raster scan monitor delivers extremely high quality video images for both viewing and photography.

Because of its 1400 line (merged raster) nominal horizontal resolution and dynamic focusing, the 634 assures clear, crisp images, even in the corners. Excellent gray scale and brightness uniformity (less than ±10% variation across the screen), mean that you get consistently accurate imaging.

The 634 is available, on a standard basis, at 525/60 and 625/50 rates. Rates of 875/60, 945/60, 1023/60 and 1083/60 can be accommodated using Option 15, providing flexibility in selecting vertical resolution. Option 14 (20 MHz video amplifier) is recommended for use with high line rates.

ORDERING INFORMATION

634 Video Display $1450
with standard resolution of 1400 lines nominal, without handle, feet or covers,
Option 01 Standard resolution of 800 lines nominal, ... Sub $180

PERFORMANCE OPTIONS

Option 11 External Sync — Switchable ..... Add $25
Option 13 Video Reverse ..... Add $50
Option 14 20 MHz Video Amplifier ..... Add $85
Option 15 High Line Rate. Factory calibrated at 1083/60. User changeable to rates between 675/60 and 1083/60 with minor modifications ..... Add $165
Option 16 Remote Brightness, Contrast, Focus, Blanking ..... Add $30
Option 20 Dc Supply +23 V, −22 V, +9 V (unreg) ..... Sub $50

SAFETY OPTIONS

Option 06 UL 544 Listing (Not available with Options 20 or 28) ..... Add $75
Option 09 UL 544 Component Recognition No Charge

MECHANICAL PACKAGE OPTIONS

Option 23 Handle, Feet and Covers (Not available with Options 20 or 28) ..... Add $60
Option 28 Covers Only. (Not available with Options 06, 20, 23) ..... Add $50

RACKMOUNT KITS

Rackmount Kit to mount two 634's side by side in a 19 inch rack. Not compatible with Option 20. Order 016-0403-00 ..... $175
Rackmount Kit to mount one 634 and one empty cabinet side by side. Not compatible with Option 20. Order 016-0402-00 ..... $195

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

620

General Purpose X-Y Waveform Display

Many Packaging Options

Exceptionally High Reliability

The 620 can be used in any situation requiring an economical, solidly performing X-Y waveform display.

Electronic instrumentation applications include pulse height, network, spectrum, logic and signal analyzers and digitizers. The 620 is also used in mechanical measurement instruments for vibration tests and NDT. In the medical field it is used for A mode imaging. The 620 offers spot size of 0.38 mm (15 mils), a 10 x 12 cm screen, and usable brightness up to 100 cd/m² (30 fL).

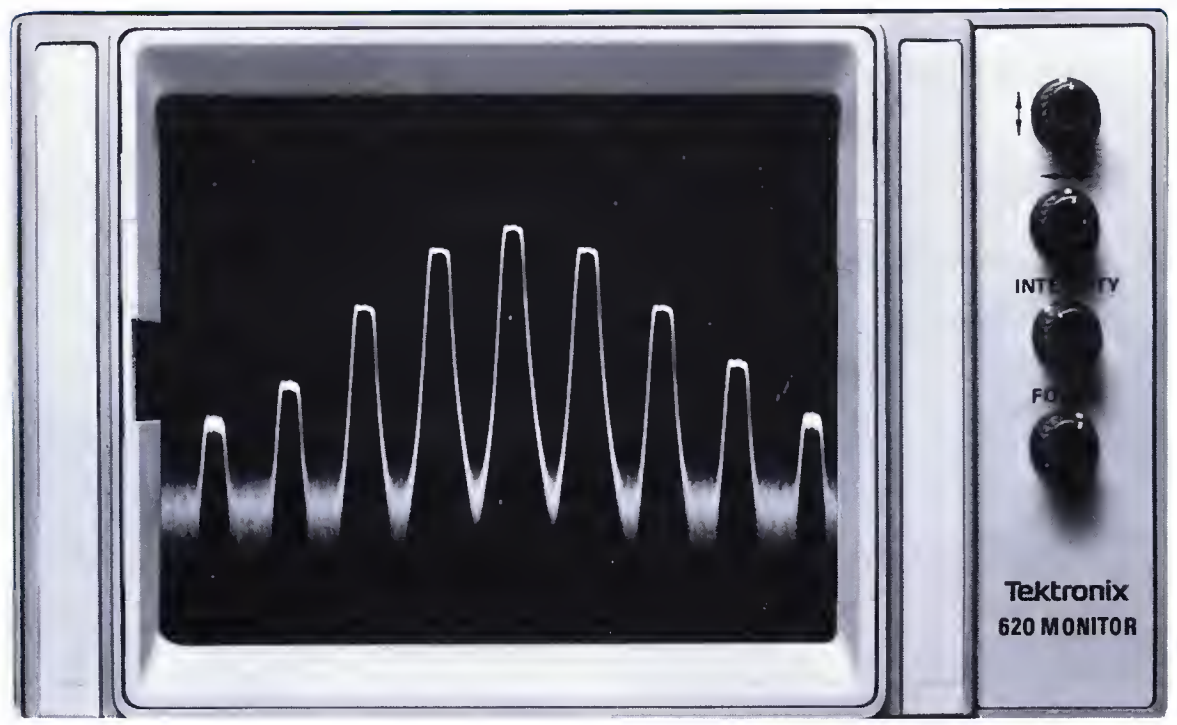
The 620 comes with a wide variety of packaging options:

1. **620 Narrow Package (MOD BD)** — As wide as the CRT bezel. Operator controls can be located anywhere on your cabinet.
2. **620 Standard Package** — Easily mounts in your custom cabinetry. Operator controls as shown.
3. **620 Stand-alone Package** — With handle, feet and covers: an excellent choice for your remote monitor.
4. **620 Horizontal and Vertical Packages** — An empty compartment next to or below the display provides ample space for your custom circuitry, resulting in an integrated enclosure.
5. **620 Rackmount Package** — Slide-out 19 inch rack assembly mounts one 620 and one compartment alongside (or two 620s side by side).

NOTE: While the 620 Narrow Package is configured for dc power only, the standard 620 can be configured for either ac power (built-in supply) or dc power from your system.

ORDERING INFORMATION

620 Display (without handle, feet or covers) ... $1,025
Option 01 With internal graticule ..... No Charge



Option 06 UL 544 Listed. Includes handle, feet and covers ..... Add $75
Option 09 UL Component Recognition* .... No Charge
Option 10 Remote 25-pin program connector, X, Y and Z axes. Single ended inputs only. (not available with Option 31) ..... Add $40
Option 20 Delete ac power. External dc power required (+17 to 26 V ≃0.9A). Not available with Option 31 ..... Sub $30
Option 23 Handle, feet and covers (not available with Options 06, 28 and modular packaging) ..... Add $60
Option 25 TTL blanking* ..... Add $30
Option 28 With cover only—no trim strips (not available with Options 06, 23 and modular packaging) ..... Add $50

Option 31 Delete all real panel BNC's, dc power connector and ac power supply and switch. Option 31 includes provision for external dc power (+17 V unregulated). All power connections and input signals are made to interconnect pins inside monitor. Not compatible with Options 10 or 20. Can be used with 016-0409-00 or 016-0410-00 packaging ..... Sub $30

MODULAR DRESS PACKAGING

Vertical package. Includes handle, feet and covers. Order 016-0409-00 ..... $175

Horizontal package. Includes handle, feet and covers. Order 016-0410-00 ..... $175

RACKMOUNT KITS

Rackmount for one 620 in a 19 inch rack. Includes frame, covers and rack slides. Not available with Options 06, 23, 28. Order 016-0404-00 ..... $195

Rackmount for two 620s side by side in a 19 inch rack. Includes covers and rack slides. Not available with Options 06, 23, 28, 31. Order 016-0405-00 ..... $175

620 Narrow Package (MOD BD) without handle, feet or covers. Dc power only ..... Request Quote

***Also available for the 620 Narrow Package.**

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

Direct Viewing Displays

608/624

High Brightness X-Y Displays

Ambient Light Viewing

High Resolution

Expansion Mesh Halo Supression

Excellent Gray Scale

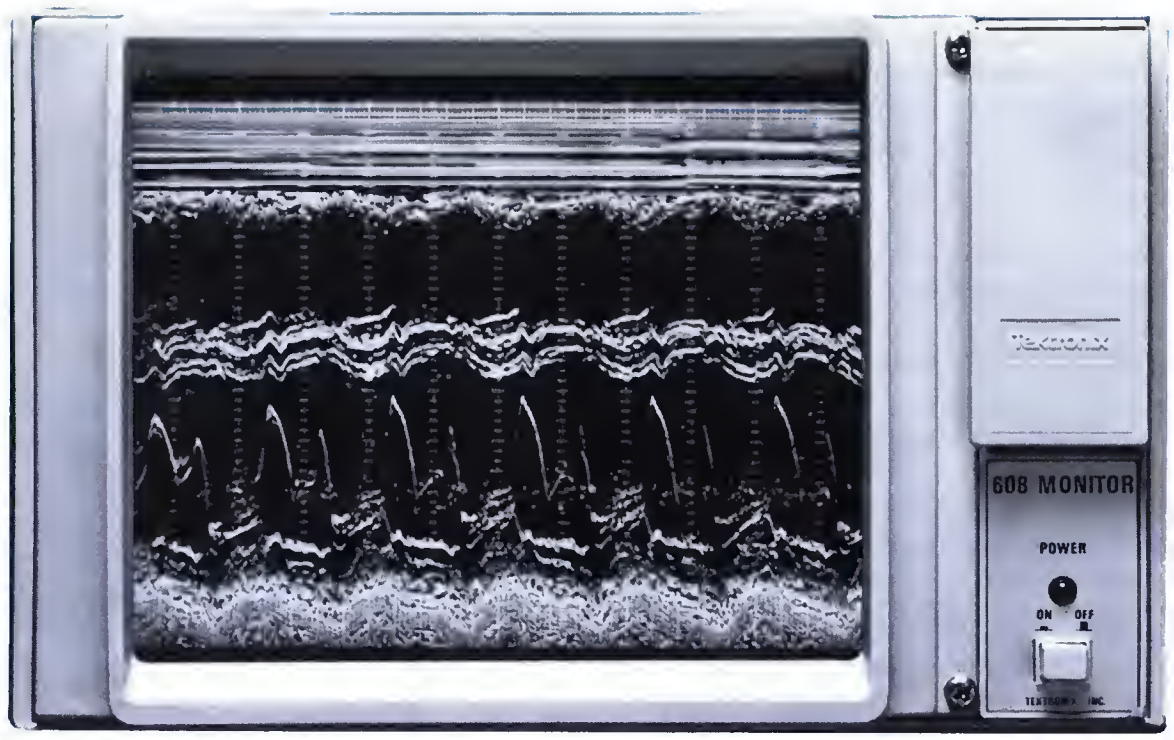
Optional UL 544 Listing

The 608 is our finest directed beam viewing monitor. It is extremely well suited for high performance imaging applications, such as diagnostic ultrasound and electronic instrumentation. The related 624, a comparable but more economical alternative, provides excellent direct viewing capability for systems that don't require optimum performance.

The 608's high usable brightness of up to 240 cd/m² (70 fL), a 0.25 mm (10 mil) spot size, and large 9.8 x 12.2 cm screen, combine to give you optimum viewing capability. Where such a high degree of clarity or brightness is not required, we recommend the 624 with a 0.30 mm (12 mil) spot size, display brightness of 135 cd/m² (40 fL), and a screen size of 9.8 x 12.2 cm. Both instruments produce detailed displays that are easy to read in high ambient light and that produce quality photographs.

Both instruments have a special expansion mesh halo suppression CRT design which eliminates annoying stray light that otherwise causes lower contrast.

The 608 displays both excellent gray scale images and detailed waveform displays, because of its small 0.26 mm (10 mil) spot size (0.30 mm or 12 mils for the 624). In addition, imaging is critically sharp from corner to corner in both instruments, using dynamic focus. (Not available on the 624.)



ORDERING INFORMATION

608 Display **$1895**
(without handle, feet or covers)

624 Display **$1675**
(without handle, feet or covers)

PERFORMANCE OPTIONS

Option 10 25-pin Remote Program Connector — X, Y and Z. Single Ended Inputs ..... Add $30

Option 20 Without ac supply—(±18 V Unregulated dc Supply Required. (Not available with Option 06) (624 only) ..... Sub $20

Option 21 Full Differential Inputs (X, Y, and Z) Add $30

Option 22 5x Attenuators ..... Add $20

Option 24 Linearized Z-Axis (Gamma Correction) (608 only) ..... Add $50

Option 25 TTL Blanking ..... Add $50

SAFETY OPTIONS

Option 06 UL 544 Listed, includes handle, feet and covers ..... Add $75

Option 09 UL Component Recognition ..... No Charge

MECHANICAL PACKAGING

Option 01 Internal graticule ..... No Charge

Option 23 Handle, Feet and Covers (not available with Options 06 and 28) ..... Add $60

Option 28 Covers Only (not available with Options 06 and 23) ..... Add $50

Option 29 Metal Bezel ..... Add $50

Rackmount kit to mount two 608s or 624s side by side, or one 608 or 624 and a 603A, 604A, 606A, 606B, or 607A side by side in a 48.3 cm (19 inch) rack. Order 040-0600-00 ..... $135

Rackmount kit to mount one 608 or 624 and one empty cabinet side by side in a 48.3 cm (19 inch) rack. Order 040-0601-00 ..... $175

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

604A

Versatile General Purpose Display

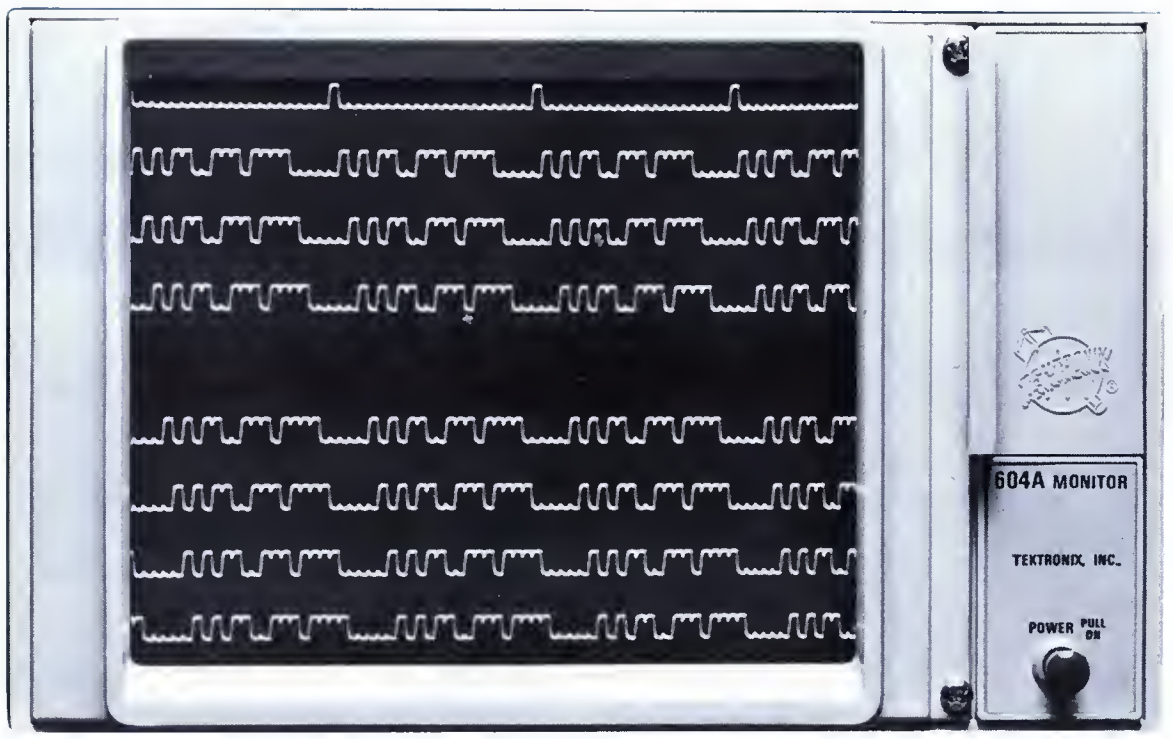
Easy Interface Options

Optional UL 544 Listing

Modular Packaging

The reliability of the 604A X-Y display monitor has been proven through its many years of use in a wide variety of electronics applications.

A wide range of options and modular packaging make the 604A a truly flexible, general purpose display for easy interface with your system. UL 544 listing optional.



ORDERING INFORMATION

604A Display **$1500**
(without handle, feet or covers)

Option 01 With Internal Graticule ..... No Charge

Option 04 Time Base ..... Add $200

Option 05 External Vector Display Graticule (P31 Phosphor Only) ..... Add $40

Option 06 UL 544 Listed; Includes Handle, Feet and Covers ..... Add $80

Option 09 UL Component Recognition ..... No Charge

Option 10 25-pin Rectangular Remote Program Connector — X, Y and Z axes; Single-ended Inputs only ..... Add $35

Option 21 Full Differential Inputs (X, Y and Z) Add $35

Option 22 Extended (x5) Gain Range ..... Add $25

Option 23 With Handle, Feet and Covers (not available with Options 06 and 28) ..... Add $65

Option 28 With Covers Only (not available with Options 06 and 23) ..... Add $55

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

606A

High Resolution 0.13 mm (5 mil) X-Y Display

Optimum Photographic Gray Scale

Multi-imaging Applications

Optional UL 544 Listing

The 606A has 0.13 mm (5 mil) resolution for applications requiring critically detailed photographs and displays.

The sharply detailed imaging provided by the 606A is particularly well suited for photographic recording applications in medical gamma camera systems and multi-imaging systems. Non-medical applications include scanning Auger and electron microscopy, and ATE.

When image stability and gray scale performance are critical to the quality of measurement or the accuracy of a medical diagnosis, the 606A's performance is consistently reliable.

Spot size of the 606A is only 0.13 mm (5 mils), for discerning even the most subtle details. And the Z-axis amplifier is very linear, with 10 MHz bandwidth. This linearity (gamma correction) provides the excellent gray scale performance you require, particularly for photography.

This display also offers excellent image stability: position shift is less than 0.1 cm per hour after 20 minute warm-up, and less than 0.2 cm in 24 hours.

Because of its high resolution, the 606A is excellent for multi-imaging: all images, regardless of on-screen location, are delivered with excellent clarity and discernability.

A broad selection of options (including UL 544 Listing) helps optimize interface of the 606A with a variety of systems.

ORDERING INFORMATION

606A Display Monitor **$2000**
(without handle, feet or covers)

Option 06 UL 544 Listed. Includes Handle, Feet and Covers ..... **Add $75**

Option 09 UL Component Recognized ..... **No Charge**
Option 21 Full Differential Inputs (X, Y and Z) **Add $30**
Option 22 5x Attenuators ..... **Add $20**
Option 23 Handle, Feet and Covers (not available with Options 06 and 28) ..... **Add $60**
Option 26 50 Ω Inputs (X, Y and Z) ..... **Add $20**
Option 28 Covers Only (not available with Options 06 and 23 ..... **Add $50**
Option 29 Metal Bezel ..... **Add $50**

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

606B

Very High 0.079 mm Resolution (3.1 mil) X-Y Display

Uniform Resolution and Variable Spot Size

Excellent Stability

Multi-imaging Applications

≤10% Light Output Variation in Quality Area

The 606B features a 0.079 mm (3.1 mil) spot size for applications requiring the most critically sharp photographs and displays.

The 606B is particularly well suited for photographic recording applications in medical gamma camera systems and multi-imaging systems. It can also provide superior imaging in such applications as electron microscopy, and radiation and thermal scanning systems.

When image stability, gray scale performance and brightness uniformity are critical to the quality of measurement or the accuracy of a medical diagnosis, you need the consistent performance and high reliability of the 606B.

The 606B also has uniform resolution and variable spot size. When dealing with a small number of data inputs, the dc programmable spot size enlarges the spots to allow them to merge into an easier-to-interpret image.

The high resolution and brightness uniformity of the 606B is excellent for multi-imaging. All images, regardless of on-screen location, are delivered with fine clarity and readability.

Optional UL 544 Listing and Component Recognition available.

ORDERING INFORMATION

606B Display **$3480**
(without handle, feet or covers)

Option 06 UL 544 Listing. Includes handle, feet and covers ..... **Add $75**
Option 07 Front panel knob controls changed to screwdriver adjustments ..... **Add $25**
Option 09 UL 544 Component Recognized **No Charge**
Option 28 Covers (not available with Option 06) **Add $50**

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

Bistable and Variable Persistence Storage Displays

603A

Bistable Storage X-Y Display

High Resolution 0.25 mm (10 mil) Spot Size

Up to 10 Hour Storage

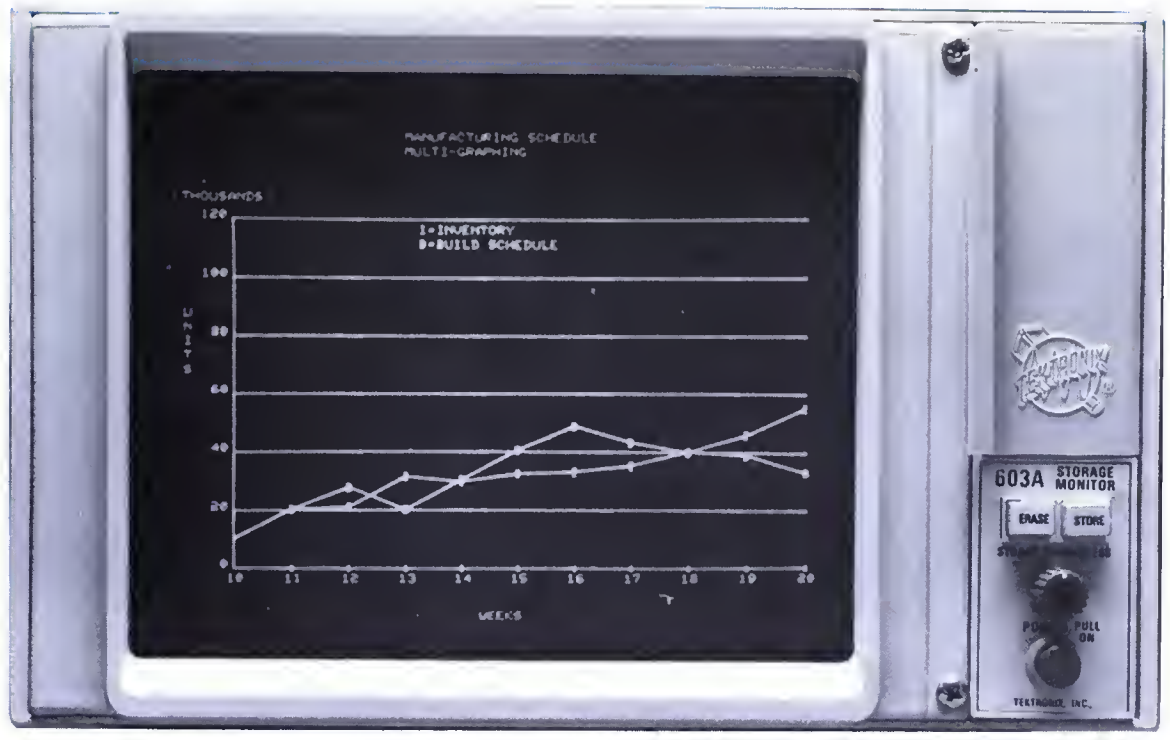
Modular Packaging

For waveform, graphics and alphanumerics, the 603A is a cost-effective alternative to digital memory. The storage capability of the 603A eliminates any need for display refreshing and associated costly memory devices.

The 603A is particularly useful in capturing and recording single, relatively slow-occurring transient events, such as in seismic analysis, mechanical shock tests. It also excels in displaying computer graphic and alphanumeric data, and in other displays where gray scale is not required. It offers storage up to 10 hours, one million dot/second stored writing speed (with Option 02), small 0.25 mm (10 mil) spot size, and a large 10.2 x 12.7 cm viewing area.

As a preview monitor the 603A can save you time and money by avoiding unnecessary photographs.

Modular mechanical packaging provides either full rackwidth or double-height instrument packages that combine your custom circuit designs with the 603A in an integrated enclosure. The 603A may also be ordered with UL 544 Listing.



ORDERING INFORMATION

603A Bistable Storage Display Monitor **$2100**
(without handle, feet or covers)

Option 01 Internal Graticule ..... No Charge
Option 02 Fast Writing Speed CRT (200 div/ms) ..... Add $40
Option 04 Time Base ..... Add $195
Option 06 UL 544 Listed. Includes handle, feet and covers ..... Add $75
Option 09 UL Component Recognized ..... No Charge
Option 10 25-pin Rectangular Remote Program Connector. Contains: Erase interval, non-store, enable/disable, erase. Single ended inputs only ..... Add $50
Option 21 Full Differential Inputs (X, Y, Z) ... Add $30
Option 22 5x Attenuators ..... Add $20
Option 23 Handle, Feet and Covers (not available with Options 06 and 28) ..... Add $60
Option 28 Covers Only (not available with Options 06 and 23) ..... Add $50

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

607A

Variable Persistence Storage X-Y Display

High Resolution 0.25 mm (10 mil) Non-Store Spot Size

Gray Scale Storage up to 50 minutes

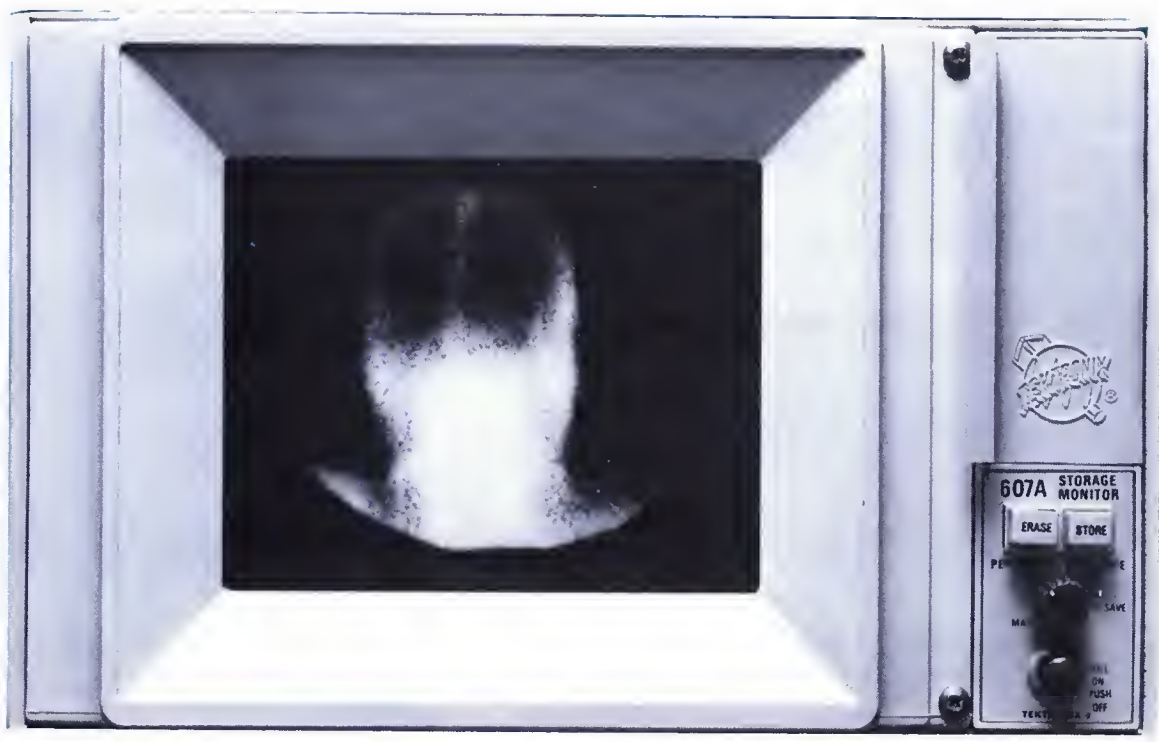
Optional UL 544 Listing

The 607A is a cost effective alternative to digital memory, since its storage capability eliminates any need for display refreshing and other costly memory devices.

This display unit is often found in gamma camera applications as a preview monitor, as well as in cardiac studies, M-mode, ultrasound, scanning Auger and electron microscopy systems. It operates in both store and non-store modes, and writes at 0.8 μs/div, with 0.51 mm (20 mil) stored or 0.25 mm (10 mil) non-stored spot size.

Adjustable persistence and the ability to display multiple successive events simultaneously enhance the 607A's applicability in areas where the highest resolution requires a slow sweep, such as in spectrum analysis, radar and sonar.

The 607A is especially useful when you require gray scale displays of multiple transient events, or for capture and storage of single-shot events. If you plan to photograph the image, the 607A is an excellent preview monitor.



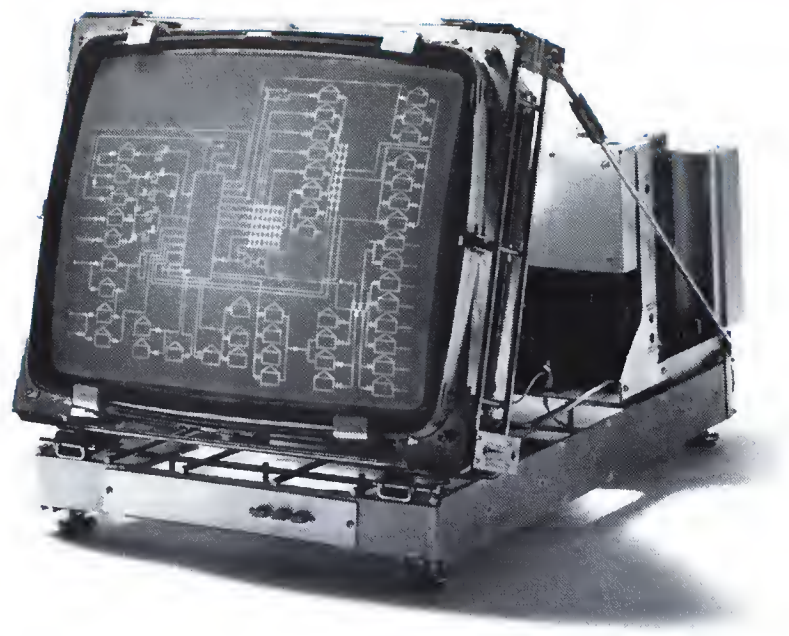
ORDERING INFORMATION

607A Variable Persistence Storage Display **$2375**
(without handle, feet or covers)

Option 01 Internal Graticule ..... No Charge
Option 06 UL 544 Listed. Includes handle, feet and covers ..... Add $75
Option 09 UL Component Recognized ..... No Charge
Option 10 25-pin Rectangular Remote Program Connector: contains remote Save, Erase, Erase Interval, Non-store. Single Ended Inputs only Add $30
Option 21 Full Differential Inputs (X, Y and Z) Add $30
Option 22 5x Attenuators ..... Add $20
Option 23 Handle, Feet and Covers (not available with Option 06 and 28) ..... Add $60
Option 28 Covers Only (not available with Options 06 and 23) ..... Add $50

SPECIAL PRICING TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

GMA 101A/GMA 102A



Both the GMA 101A and GMA 102A are 483 mm (19″) diagonal modular graphic and alphanumeric storage displays. The GMA 101A is a storage-only display. The GMA 102A is a higher performance instrument that also has refresh capability. Both are configured for optimum modularity, with printed circuit board modules arranged on a unique high-strength wireform chassis. This construction not only supports different performance, interface and packaging options, but permits easy removal of modules for field service.

The GMA 101A — high resolution storage. The GMA 101A makes the benefits of low cost, high resolution storage technology graphics available to the OEM system builder in a modular display. This family member is tailored for an application that emphasizes storage graphics. You can use our options or yours to take advantage of the very fast stored data-drawing capability of the GMA 101A — 3900 inches per second. At this drawing rate, the entire screen can be redrawn in less than one second, permitting effective zooming or panning. In addition, data or picture editing can proceed with minimal thought-process interruption. You can achieve high density interactive graphics while freeing your computer to address the application rather than drive the display.

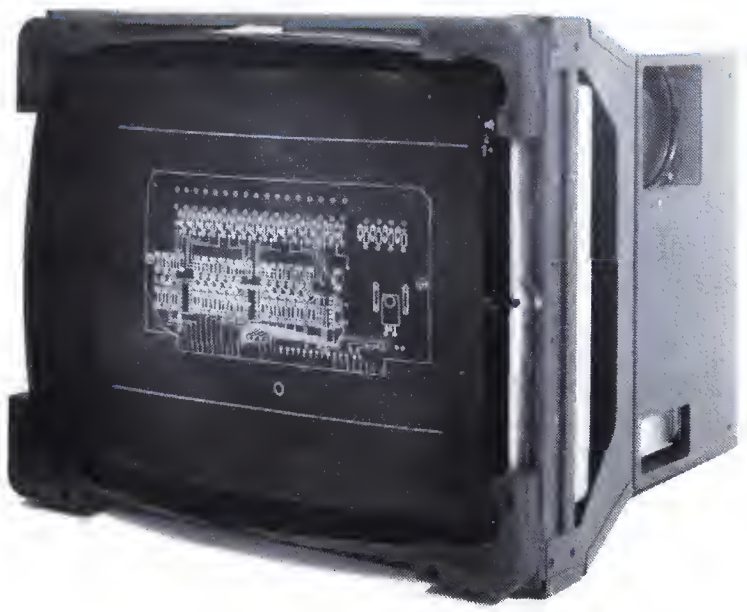
The GMA 102A — storage and refresh. With the GMA 102A, you can display up to 1575 vector inches (30 Hz refresh rate) of refresh data while simultaneously having all of the benefits of storage technology. The storage mode presents high resolution, high density graphics at low cost, while the refresh feature adds the benefits of selective erase, interactivity and dynamic motion with the same high resolution of storage. By placing fixed or finalized data in store while retaining dynamic or working data in refresh, you can achieve high density, interactive graphics while making maximum use of your computer to address the application task rather than support the display.

Operation — both instruments. All display functions are completely programmable and designed to interface to TTL logic. They are Write-Thru (GMA 102A only.) Non-Store; Brite, Defocus, Center, Copy, Erase, View and G Busy.

Options Addressed to the OEM. Both instruments in the standard display format are driven as X-Y directed beam displays using analog inputs. Both have clear glass light filters and are compatible with Tektronix hard copy units. On either, the display can be supplied with the CRT module tilted as far back as 15° or oriented in either the horizontal or vertical (page) format. Space has been left in the card cage for you to add up to three circuit boards with your application options. Additionally, on the GMA 102A, our Option 42 Vector Generator or Option 43 Vector/Character Generator can be plugged into two of these positions to give you a completely digital interface (16 bit word format plus control and status signals).

On both instruments, you can use your interface connector or ask for our Option 34 (analog) or Option 35 (digital) connector as appropriate.

GMA 125



The GMA 125 was designed exclusively for systems builders, and is intended to satisfy display applications of the greatest size and complexity. It incorporates 65 percent more workspace than even our own previous industry leaders, the 483 mm (19″) GMA 101A and GMA 102A. Like other members of the GMA series, it provides low cost, high resolution, storage tube graphics and unique flexibility of performance, interfacing and packaging.

Further, the GMA 125 offers that same powerful combination of simultaneous storage and refreshed displays that was first provided in the GMA 102A.

The detail of storage. The dynamics of refresh. The GMA 125 features a 635 mm (25″) CRT that offers unequaled information display capacity. Adjacent points that would be indistinguishable on a smaller screen can be seen as distinct units on the GMA 125. It is ideal for group viewing and for greater graphics detail. A new 110° CRT provides greater display brightness with less energy consumption in a more compact package.

The GMA 125 will display up to 1968 vector inches of refreshed data, enabling all the benefits of selective erase, interactivity and dynamic motion with the same high resolution of storage.

By placing fixed or finalized data in store while retaining dynamic or working data in refresh, you can work interactively with high density graphics and alphanumerics while making maximum use of processing power to address the application rather than support the display.

Modular design assures ideal building economy. Order CRT, chassis and power supply only, or configure your GMA 125 to best fit your own manufacturing capabilities and system specifications. The welded-steel, symmetrically structured chassis may be rotated vertically or horizontally, and tilted to any degree. Space is left in the card cage for your own application options. Or you can plug in our Option 42 Vector Generator or Option 43 Vector/Character Generator to provide you with a completely digital interface (16 bit word format plus control and status signals). You can use your interface connector or our analog or digital interface options.

Colored light filters and several other support options are also available.

Operation. The standard display instrument is driven as an X-Y directed beam display using analog inputs. The CRT beam is positioned at center screen with zero volts applied. All other display functions are completely programmable and designed to interface to TTL logic. The display functions are Write-Thru, Non-Store, Brite, Defocus, Center, Copy, Erase, View and G Busy. The Z-axis input is a digital signal.

Image Forming Modules

4633A (OEM Only)

Line scan recorder

Black on white or gray scale

Excellent resolution

Low copy cost

100 mm/s paper speed

The Tektronix 4633A Continuous Recorder is designed to provide hard copy output from systems that provide a Z-axis input signal simultaneously with an X-axis (horizontal ramp) signal. It is uniquely suited to the requirements of the medical echocardiography market and can also be modified to suit other applications where there is a need for recording real time data.

The 4633A has three basic speeds, selectable on the front panel: 10 mm/s, 25 mm/s, and 50 mm/s. Another switch allows the operator to double each of the three basic speeds. This provides a maximum speed capability of 100 mm/s and also gives the operator considerable operational flexibility.

The 4633A is available as either a rackmount or benchtop model. The rackmount version fits into any standard 19-inch (482.6 mm) rack.

The medium: high performance/low cost, dry process, full-size paper. The 4633A is designed for high performance/low cost dry silver paper: The state of the art in dry process gray scale.

After the paper has been exposed by a fiber optic CRT, it passes through a processor, where the latent image is thermally developed. The developed image is transported by a conveyor through an opening in the front panel.

Unwanted interruptions will be minimal. Big 500-foot paper rolls mean few time-outs for reloading. The paper is a full 8½″ wide.

The 4633A's image quality, convenience, reliability, and competitive pricing combine to make it a valuable component of an OEM system.

4634

Photographic quality images

Excellent gray scale and resolution

Compatible with most raster scan video systems

Dry, quick, convenient process

Large, file-sized image

Low copy cost

The Tektronix 4634 Imaging Hard Copy Unit is designed to record images of photographic quality from raster scan video sources. It is suited to a variety of industrial, commercial and medical imaging applications.

The 4634 is easily coupled to video sources, both analog and digital. It can be adjusted to accommodate a wide range of line rates: from 525-1029 lines interlaced, and from 256-512 lines non-interlaced for both 50 Hz and 60 Hz systems. If image size is reduced, higher line rates are achievable.

The 4634 is available as either a rackmount or benchtop model. The rackmount version fits into any standard 19 inch (482.6 mm) rack.

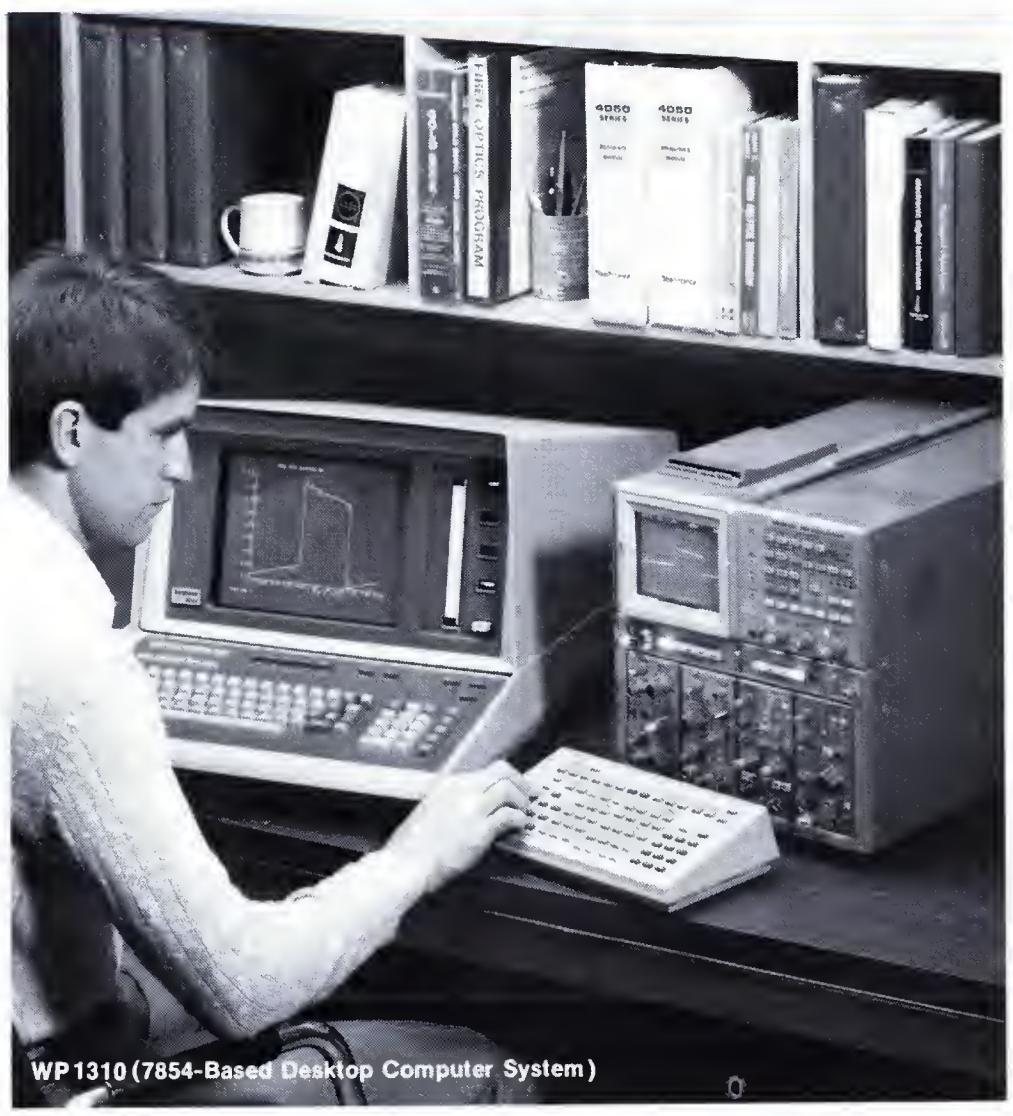
The 4634 uses a cathode ray tube (CRT) to expose the image on dry silver paper. A fiber optic faceplate on the CRT effectively couples the light output to the paper, providing photographic quality images of fine detail.

After exposure, the image is developed in a Thermal Processor. The entire process of exposure and development is completed in just 26 seconds. The costs of space, equipment, and labor associated with wet process films are eliminated.

Users may select two types of paper: standard performance for lowest cost per image, and high performance for optimal image quality. Both paper types are significantly less expensive than film.

The combination of high image quality, operational simplicity, speed and convenience, and low cost makes the 4634 Imaging Hard Copy Unit an excellent choice for a wide variety of raster scan video applications.

Signal Processing Systems



WP 1310 (7854-Based Desktop Computer System)

WP 2250 (7912AD-Based Computer System)

Precise Automatic Waveform Measurements for Demanding Applications in Research, Design, Manufacturing and Quality Assurance

Automatically save hours, days, even months of work.

Tektronix Signal Processing Systems are specially designed to handle the increasingly complex, expensive, and time-consuming task of waveform characterization.

They're the first measurement systems to offer all the power and flexibility of oscilloscope acquisition, coupled with fully automatic analysis. They're the first systems to feature signal processing software with extensive control over instrumentation, waveform manipulations, and graphic display. And they're the first to provide system compatibility that allows configuration for many types of test and measurement applications.

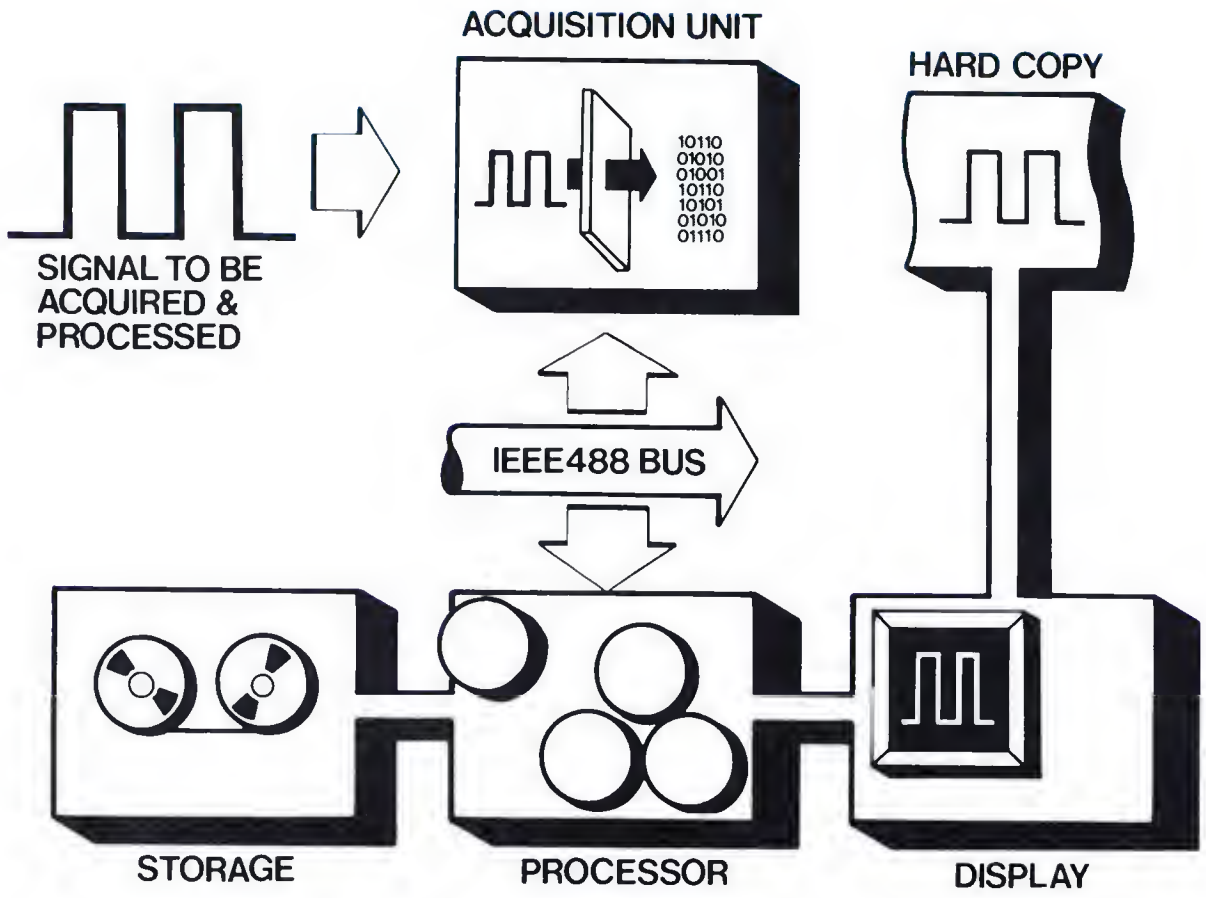
With Tektronix Signal Processing Systems you concentrate on test results, not test procedures. There's no human-eye interpretations, hand processing, or complex statistical graphing. Tektronix Systems automatically capture the signals you need, make the measurements you want, then display, store, and document your solutions.

This means work that used to take hours, now takes only minutes. System automation saves you time and money by greatly increasing your productivity. Projects not only get completed on schedule, they get completed on budget.

Plus, system automation gives greater measurement accuracy and accountability on your finished product. Since there's less operator involvement in measurements, there's less chance of human error.

From today's research and development tasks to tomorrow's production testing, Tektronix Systems give you all the capabilities needed to characterize your waveforms quickly, efficiently, and automatically.

For measurement solutions, you can't beat the SYSTEM



FIVE MAJOR SYSTEM COMPONENTS AND TEK'S COMPREHENSIVE SOFTWARE MEET YOUR MEASUREMENT NEED

Acquisition, built around Tektronix GPIB Waveform Digitizers and 7000 Series Oscilloscope Plug-ins, captures analog data, converts and stores it in a digital format acceptable to the system processor.

Processor, either minicomputer or desk-top computer, controls the system, accepts the digitized data, and then performs the needed mathematical calculations and operations.

Mass Storage, in the form of disk or magnetic tape, keeps a log of the processed data and also stores the test programs.

Display, including graphic terminal and **Hard copy units,** provides both alphanumeric and graphic presentation of data and permanent documentation.

Software, specially developed for ease of use with Tektronix Signal Processing Systems, controls all other system components and performs the desired computations. Commands are high-level BASIC and accessible through a standard terminal keyboard.

A WIDE RANGE OF SYSTEM PRODUCTS PROVIDES THE SOLUTIONS YOU NEED

Signal acquisition. Fast or slow, transient or repetitive.

The growing family of GPIB compatible 7000 Series Waveform Digitizers provides a broad range of acquisition capabilities. They offer the ability to analyze signals ranging from seconds to picoseconds in duration, and risetimes to 25 ps. Plus, all are compatible with a broad range of 7000 Series Plug-ins.

7912AD*

For high-speed transient signal acquisition, the 7912AD Programmable Digitizer has the capability to capture signals in the millisecond to subnanosecond range with a bandwidth of up to 500 MHz.

7612D*

For medium-speed signals, the 7612D Programmable Digitizer offers dual channel acquisition, selectable sampling rates within records, and pre- and post-triggering. With the 7612D you can capture transient signals from seconds to sub-microseconds in duration with high resolution.

7854 and DPO*

For fast, repetitive signals, the 7854 Oscilloscope or the DPO are ideal when configured in a system. The 7854 features an on-board microprocessor. This instrument provides the system with the capability to acquire high speed signals with risetimes to 25 ps.

*Digital Mainframes Section for details.

System controllers dedicated to speed and precision.

Tektronix Signal Processing Systems are divided into two major processor families: the minicomputer family, and the desktop computer family.

The Tektronix minicomputer systems, built around DEC PDP11 compatible controllers, are designed to handle large amounts of data. They offer flexibility in peripheral selection, processing speed, and up to 128K words of memory space. Plus, the software support is specially developed for waveform manipulations, array processing and display efficiency.

The desktop computer systems are built around the 4052 Desktop Computer—one of the most powerful analytical performers available today. Its built-in extended BASIC software is complemented by special ROM packs featuring commands most often used in signal processing applications.

Wide-ranging system peripherals for full documentation and display.

The end result of any measurement is the display of the solution; and the quality of that solution is often dependent on the quality of the display. Once again Tektronix Signal Processing Systems provide the best—the 4010 or the 4052 graphic screen. These terminals provide an excellent medium for displaying graphic and alphanumeric information with high resolution. In addition, a wide range of system peripherals is available, including graphic plotters, hard copy units, disk and magnetic tape storage devices.

SPS Software for Power & Control

Whatever your choice of systems might be, you are assured of receiving truly powerful yet easy to use software to control your measurement solution. The system descriptions in this section highlight the unique capabilities available to you.

The WP3201 is one of the many configurations for the minicomputer-based systems.

Systems

Tektronix Minicomputer-based systems offer combinations of Tektronix Waveform Digitizing instruments, flexible instrument controllers, and the most powerful waveform (array) processing BASIC software available on the market. These systems are tailored for medium and large scale experiments and for use in areas where medium or high power, dedicated systems are best suited to the task. System versatility and easy-to-use software allow for a wide variety of tasks to be performed at a multi-purpose test area. Large amounts of data storage and waveform analysis are manageable under the TEK SPS BASIC operating system which handles full arrays of data as easily as single-valued variables.

Instrument control and data communication are accomplished over the IEEE-488 (GPIB) bus, allowing for easy expandability. Multiple instruments performing different functions may be added as needs expand or change. Control or data busses other than GPIB may be added by the user and controlled by TEK SPS BASIC software.

Mass storage includes either floppy or hard disk systems for operating system, non-resident commands, data files and user program storage. Hard copy capability may be added by ordering the Tektronix 4631 option to these systems.

AVAILABLE MINI-COMPUTER BASED SYSTEMS

	DPO	7912AD	7612D
CP4165/Floppy Disk	WP1200	WP2250	WP3200
CP1164X/Hard Disk	WP1200 w/options	WP2250 w/options	WP3201

TEK SPS Basic Software.

TEK SPS BASIC is a powerful general purpose programming language which offers convenient control of instruments to acquire, process, store and display data with ease. It is an enhanced version of BASIC making it easy to learn and use.

Modular, space-efficient and versatile, TEK SPS BASIC can serve needs ranging from a new user's five-line arithmetic calculation program to an experienced assembly-level programmer's specialized device driver. With TEK SPS BASIC a novice will not be overwhelmed with programming complexity, while an expert will never feel limited by its simplicity.

Under Your Control.

Through simple single statement commands you can control the powerful operating system. TEK SPS BASIC combines the advantages of being an interactive language with the high performance of a computer operating system. Monitor level commands provide program, system and file control, plus communication with all instruments on the GPIB. And since TEK SPS BASIC is modular in design, you can easily integrate new capabilities into your system.

Waveform Processing *a la carte.*

TEK SPS BASIC offers a unique way to process waveforms—as if they were single valued variables. The monitor and signal processing package contains a full range of waveform processing functions from simple arithmetic calculations to the more complex fast Fourier transform—all accessible by a single command. Scaling and unit changes are automatically performed, providing results ready to be displayed.

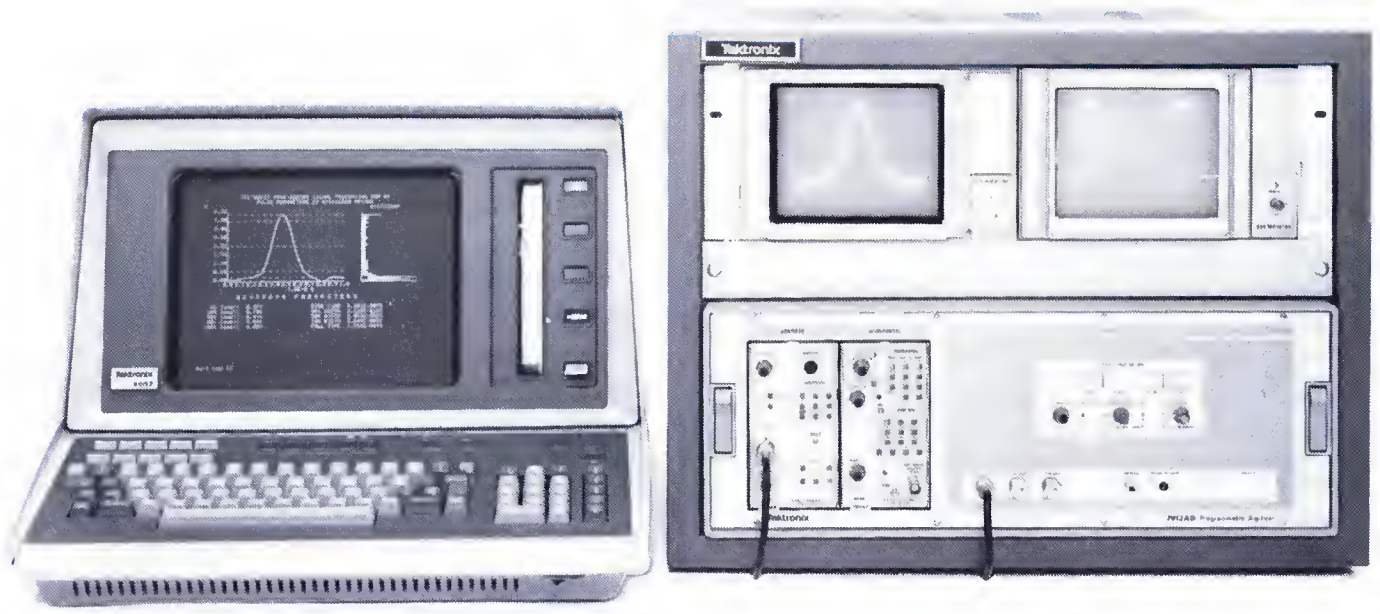
Graphic software for answers you can get your hands on.

TEK SPS BASIC also provides a powerful package for presenting results in a format best suited to your needs. You simply select the graphics you want . . . from single waveform graphing commands . . . to a complete selection of instructions to help generate your own format such as bar charts, waveform displays, three dimensional functions . . . the choices are yours.

Warranty

Systems defined as "WP" Systems are installed at the user's site free of charge. On-site warranty is for 90 days from date of system start-up, or 120 days from date of shipment, whichever is shorter. Individual instruments are warranted for one year at a Tektronix Service Center. Post-warranty service is available on a normal charge basis, or system components may be sent to a Service Center for repair.

Desktop Computer Based Systems



The WP2110 is one of four desktop computer-based systems.

Systems

Tektronix Desktop Computer-based Systems offer combinations of Tektronix Waveform Digitizing instruments and the 4052 Graphic Computing System. These systems are tailored especially for single user, small and medium scale experiments and for use in areas where medium power, dedicated, self-contained systems are best suited to the task. Each system contains the flexibility to be easily moved between areas or to perform a variety of tasks at a multi-purpose test bench.

Instrument control and data communication are accomplished over the IEEE-488 (GPIB) bus, allowing for easy expandability. Multiple instruments of the same type or GPIB-interfaced instruments performing different functions may be added as needs change. Data communication with external intelligence for additional flexibility is available via an RS-232C port. Hard-copy capability from the display may be added by ordering the Tektronix 4631 option to these systems. Raw and processed data and user programs may be stored using the integral magnetic tape, or the Tektronix 4907 flexible disk File Manager may be ordered to supplement the system.

Desktop Graphic Computer and Display

The Tektronix 4052 Graphic Computer has gained wide acceptance as a powerful data processing tool for system applications. For rapid calculations this desktop computer contains a fast processor with microcoded floating point.

The 4052, with state-of-the-art graphics capability, can provide hard copies of any combination of text and high density graphics via an optional hardcopy unit. For peripheral support the 4052 uses the GPIB and RS-232C to interface with additional instruments as your needs require. And with memory expandable to 64K bytes, the 4052 can handle lengthy programs and large amounts of data.

AVAILABLE DESKTOP COMPUTER-BASED SYSTEMS

	DPO	7854	7912AD	7612D
4052	WP1110	WP1310	WP2110	WP3110

For complete information on SPS Systems and Digitizers described, contact your SPS Specialist for data sheets and descriptive literature through your nearby Tektronix Field Office.

Desktop Computer Software.

4052 software is an easy-to-learn enhanced form of BASIC which provides the simplicity desired by the beginner and the flexibility and power required by the experienced programmer. Device independent keywords make programming input and output operations easy. Fast matrix functions are also part of 4052 BASIC. Special ROM Packs provide 15 commonly used waveform processing functions—from the location of waveform maximums and minimums to fast Fourier transforms. And Tektronix supports the software of the 4052 with an extensive applications software library — including mathematics, statistics and graphics packages — which aids the user in solving measurement problems from modeling to final report generation.

For graphic display control, an entire set of commands allows graphic displays to be created on the 4052. For example, one ROM Pack command provides the ability to display a complete array of data with a single statement.

Broad Support Completes the Package and Assures You of Continuing Value

From signal acquisition through final display, ongoing support guarantees you the most value for your investment dollar. The many support programs available are yours as a part of your system purchase.

HANDSHAKE is a newsletter forum for users of TEKTRONIX programmable instruments and systems. Published quarterly, HANDSHAKE has articles of interest concerning applications of measurement and analysis techniques.

SPS PROGRAMMING UPDATE is published periodically and sent to users of TEKTRONIX Signal Processing Systems. It contains information to help maintain software and firmware system components. It also contains useful programming hints and software and firmware product information.

TEKTRONIX also offers complete training in TEK SPS BASIC software and the operation of signal acquisition and processing systems.

Most important of all a staff of Signal Processing Systems Specialists, located at various offices, stand ready to assist you in all aspects of system specification and performance.

Tektronix offers training classes in TEK SPS BASIC Software and the operation and maintenance of typical signal acquisition and processing systems. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

7000 Series Instruments

The 7000 Series . . . more than an oscilloscope

Reference	Page 75
7000 Series Nonstorage Mainframes	Page 83
7000 Series Storage Mainframes	Page 96
7000 Series Digital Mainframes	Page 103
7000 Series Plug-ins	Page 111

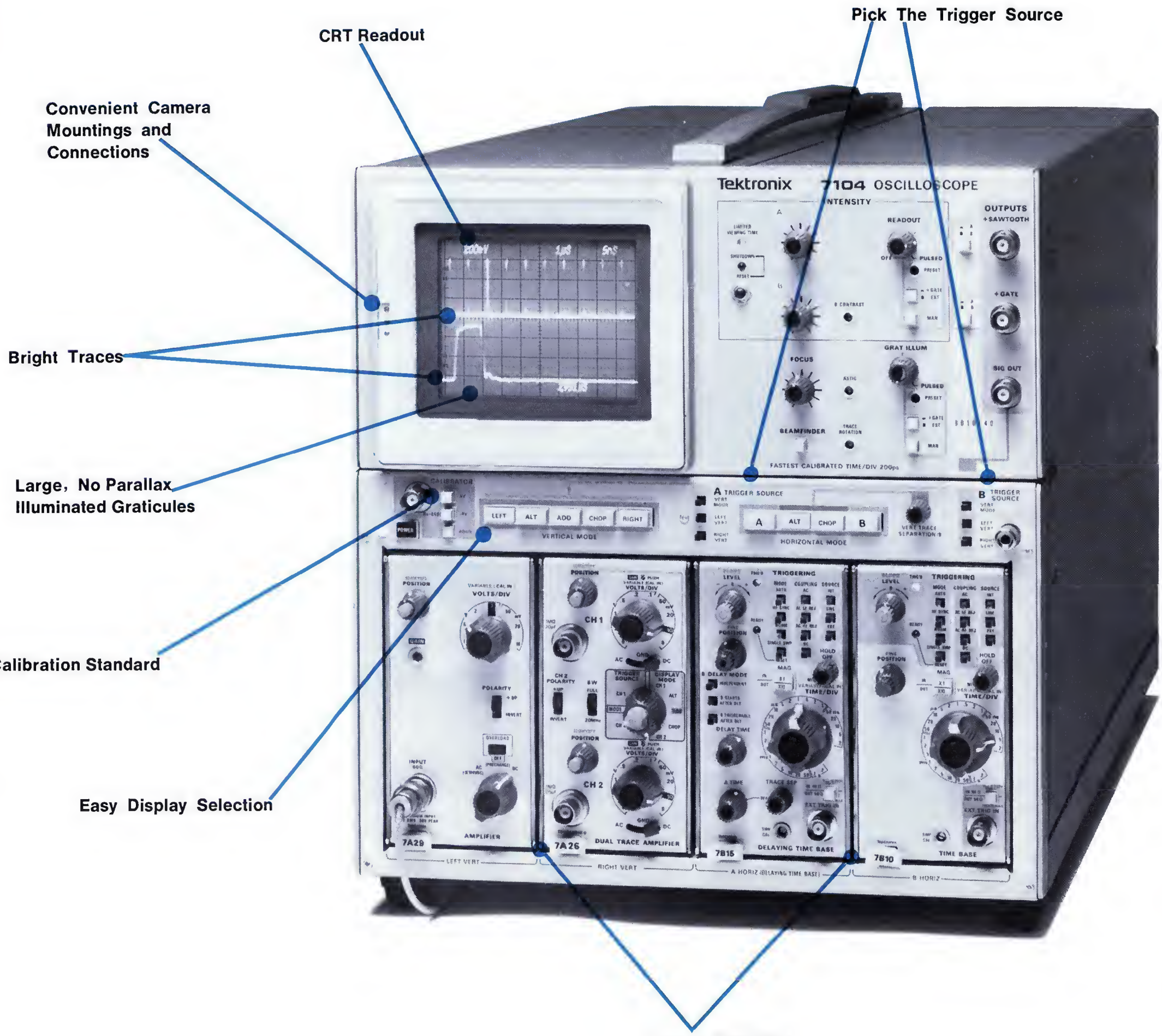
Pick a Plug-in Oscilloscope for:

Superior Performance. The 7000 Series of plug-in laboratory instruments embodies more state-of-the-art performance features than any other oscilloscope-based measurement system. The 7104 Oscilloscope features a 1 GHz bandwidth combined with the fastest rise time and writing speed available today.

Flexibility. A choice of over 35 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual needs. When your needs change, your present package can be reconfigured with a minimum of additional equipment and effort.

Expandability. This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Three of Tektronix' most recent developments in plug-in scope capability are: The Fast Storage Oscilloscope, the Logic Analyzer Plug-in, and the Spectrum Analyzer Plug-in.

7000 Series . . . high performance, flexibility and expandability



The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix committment to bringing the ultimate in measurement technology to the laboratory.

Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent cathode-ray-tube mainframes and instrumentation plug-ins.

A system can be tailored for your exact measurement needs. Mainframes in the family offer a choice of popular bandwidth ranges and a wide selection of additional features. Plug-ins—including oscilloscope vertical amplifiers and time bases as well as instruments for a variety of applications—can be selected to round out your tailored system.

In opposition to an industrial world that is frequently faulted for planning obsolescence, this instrument family strategically defers obsolescence. Each mainframe and each plug-in reflects the latest technology at its inception, yet each fits a well-planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to our new developments while protecting your initial investment. Today's system may be expanded to meet future needs at a relatively low cost by the addition of a plug-in or two. When the time comes to add a more powerful mainframe, your older model continues to be useful for a host of applications.

CRT Readout*

All significant parameters are displayed in alphanumeric characters right on the CRT. They are readily visible when you need them for quick oscilloscope measurements, and they are permanently recorded on your waveform photographs for future analysis. When your 7000 Series Measurement System includes a digital instrument plug-in, the measurement is presented in clear, accurate digital terms, along with a corresponding analog waveform.

Bright Traces

All 7000 Series CRTs have bright displays and excellent photographic writing speeds. For applications requiring maximum photographic writing speeds, several mainframes feature a reduced scan on a reduced area in the center of the CRT, and one uses a micro-channel plate CRT.

Large, Illuminated and Parallax Free Graticules

The display area is 8 by 10 divisions (0.85, 0.9, 0.98, 1.0, or 1.22 cm/div depending upon mainframe) with a parallax-free graticule.

*Not available in mainframes or plug-ins with "N" suffix.

Convenient Camera Mountings and Connections

A standard bezel connector matches all TEKTRONIX Oscilloscope Cameras to 7000 Series Mainframes.

Independent Intensity Controls

Separate intensity controls allow for independent adjustment of A sweep, B sweep, and character readout brightness. The intensity of each sweep may be adjusted to a level that suits your application.

Autofocus

The trace stays in focus with changes in intensity. After the focus is initially set, an autofocus circuit reduces the need for additional adjustments.

Adjustable Graticule Illumination

This gives you easier viewing and sharper photos.

Plug-ins

Flexible Measurement Systems

More than thirty plug-ins provide you with flexibility to choose just the measurement capability you require.

Analog/Digital Synergism

Digital instrumentation plug-ins create unsurpassed measurement capabilities. Highly accurate digital measurements may be made at selectable points on complex waveforms by visually superimposing gate waveforms over signal waveforms.

Mainframes

Calibration Standard

All the 7000 Series Calibrators serve as a voltage standard for calibrating vertical plug-ins, a 1 kHz square wave for adjusting probe compensation, and a 1 kHz frequency standard in the 7800, 7900 and 7100 Series Mainframes. The output is available in several dc or 1 kHz square-wave voltages.

Trigger Source Flexibility

The left and right trigger selector mainframe pushbuttons route the desired trigger source to the appropriate time base. A VERT mode position automatically routes whichever source has been chosen for vertical inputs.

Easy Display Selection

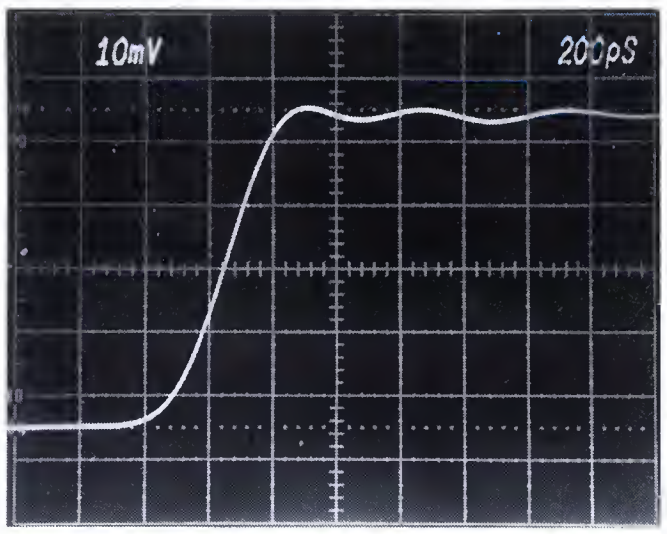
Vertical mode switches allow you to easily select the desired vertical amplifier or interaction of amplifiers (e.g., alternate, chopped, or added modes). Four-compartment mainframes provide equivalent flexibility for time bases as well.

Mainframe Flexibility

Numerous options add even more flexibility in creating the oscilloscope system that most closely meets your measurement requirements.

7000 Series Reference

7104 NON-STORAGE



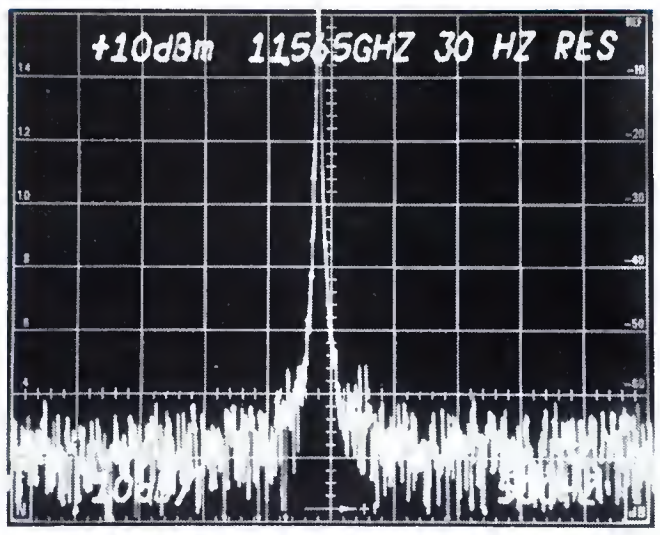
1 GHz Bandwidth

10 mV/div Sensitivity

200 ps/div Sweep Speed

20 cm/ns Writing Speed

SPECTRUM ANALYZER



Accurate Amplitude Measurements at 11 GHz

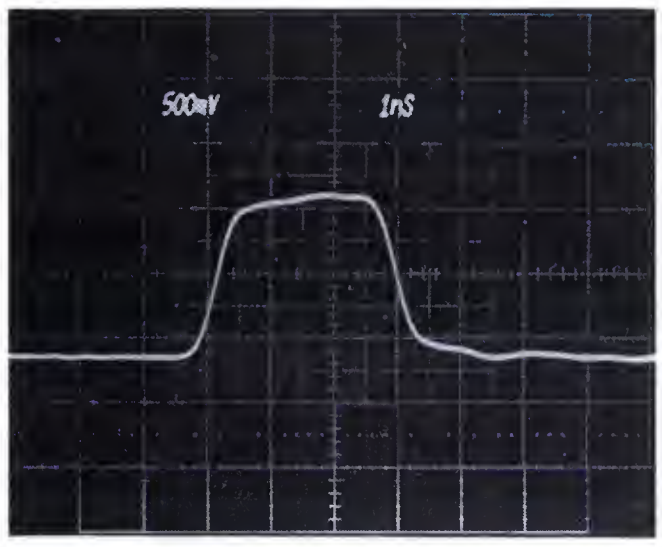
Crisp, Clean Displays via Low Residual FM'ing

60 dB Dynamic Range at Offset Frequencies as Low as 500 Hz

Spurious Free Displays with Internal Calibrated Preselector

Flicker Free Digital Storage

FAST CRT STORAGE



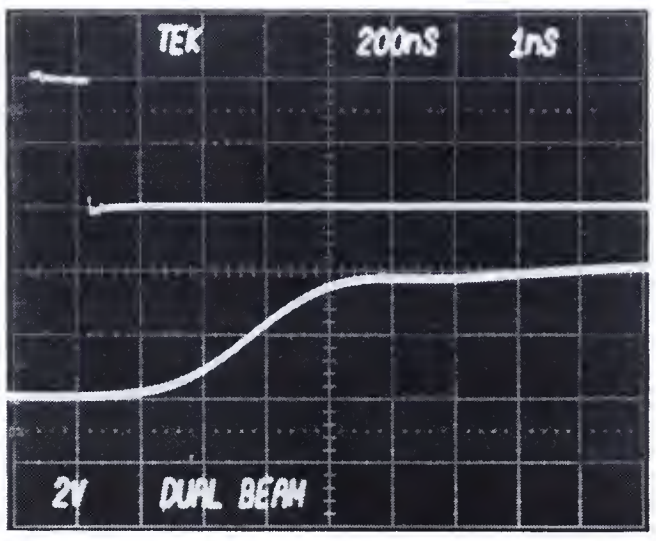
Readout Stored with the Waveform

Fast Stored Writing Speeds

Multimode 7834/7633/7623A

Variable Persistence 7613

DUAL BEAM

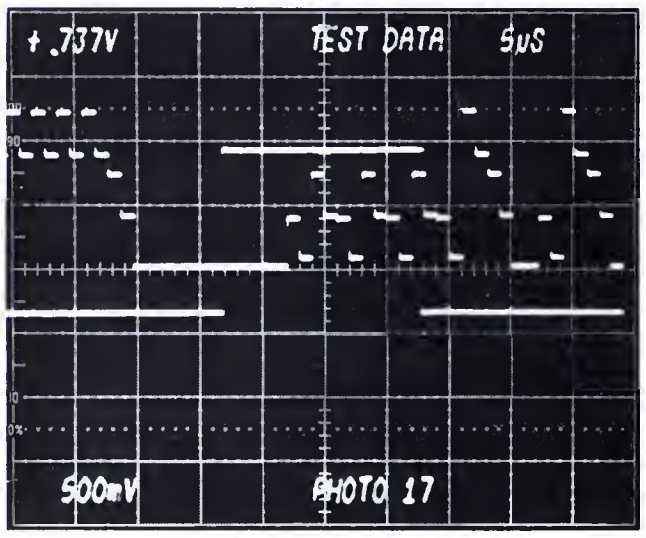


400 MHz Bandwidth

Full Vertical and Horizontal Cross-over Switching (one input shown at two sweep speeds)

Full Overlap on 8 x 10 cm Display

DIGITAL READOUT MEASUREMENTS



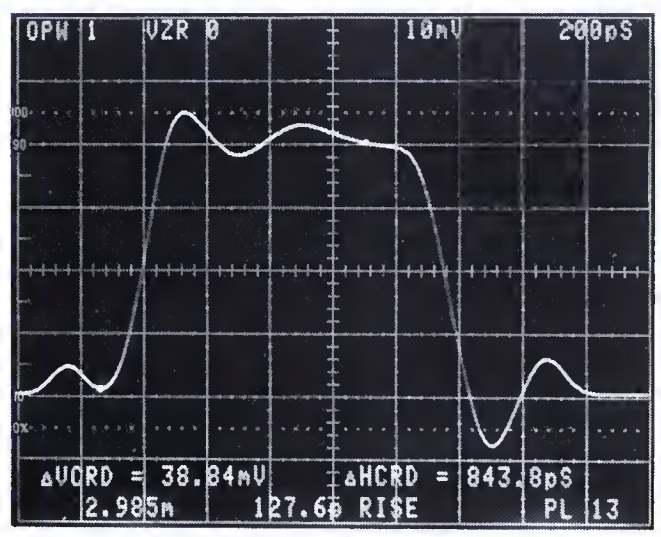
Sample and Hold Dvm Measures Voltage Difference between Two Points on Complex Waveform (gate waveform indicates two points—leading and trailing edges—where voltage difference is made—+0.737 V)

Readout Unit Identifies this Waveform as TEST DATA-PHOTO 17

Counter/Timer Measurement with Analog Display

Compare Digital Measurement with Analog Display

DIGITAL STORAGE/ PROCESSING



Store Repetitive Signals up to 400 MHz with Standard Plug-ins, and up to 1 GHz with the 7S12 Sampler

Digital Storage with Waveform Processing

Common Waveform Measurements at the Touch of a Button

Keystroke Programming

GPIB Interface

7000 Series Storage Oscilloscopes

Storage, as it applies to most instruments in the TEKTRONIX 7000 Series, involves techniques for capturing and retaining signals within the cathode-ray tube itself, or as numeric values in digital memory.

Why Store?

Capturing an event for detailed analysis is perhaps the most obvious application for a storage CRT, but many other situations also call for its unique advantages. Some examples include capturing the entire display of a slowly occurring signal . . . observing signal changes during circuit adjustment . . . comparing incoming signals with a standard . . . increasing the brightness of a repetitive signal for viewing in normal ambient light . . . reducing flicker or noise . . . baby-sitting, or unattended monitoring for a transient event . . . and enhancing other recording techniques such as photography.

Storage Features

Since 1962, when Tektronix introduced phosphor target bistable storage in the 564, techniques for capturing and retaining waveforms have grown at an explosive rate in order to keep pace with measurement demands.

However, the language of storage—such terms as bistable, variable persistence, mesh transfer and digital storage—frequently presents as much confusion as the measurement that must be made.

Characteristics of individual 7000 Series Mainframes employing storage techniques are listed on pages 96 through 110. A review, though, of storage concepts should prepare the reader to evaluate the various alternatives more knowledgeably.

Digital Storage

The fundamental difference between the digital storage scope and the CRT storage scope is the form of storage. Digital scopes store data representing waveforms in a digital memory; CRT storage scopes store waveforms within the CRT. Digital storage requires digitizing and reconstruction processes. "Digitizing" consists of "sampling" and "quantizing." Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC) in the digital scope. You determine how often digitizing occurs by the time base. The time base uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. The rate at which this happens is the digitizing rate (or sampling rate).

Once the data is in the digital memory, it can be read out and reconstructed for displaying or further waveform processing.

Bistable CRT Storage

Bistable storage, available as one storage mode on the 7834, 7633 and 7623A Mainframes, employs a mesh between the electron gun and the CRT phosphor. It features bright, long lasting displays with reduced contrast.

Variable Persistence CRT Storage

Variable persistence storage is available in the 7613, 7623A, 7633, and 7834 Mainframes. It features bright, high contrast displays and controlled persistence.

A front-panel persistence knob provides control of the decay (fade-away) rate of the stored image. The rate can be varied from almost instantaneous disappearance to a view time of greater than 15 s in the 7613 (30 s in the 7623A, 7633, and 7834).

Fast Multimode CRT Storage

Fast multimode storage, available in the 7623A, 7633, and 7834, provides four storage modes. The four modes combine the previously discussed bright bistable and variable persistence storage modes with fast bistable and fast variable persistence.

The display characteristics of fast bistable and fast variable persistence are the same as bistable and variable persistence respectively. In either fast storage mode the trace image is first written on a fast mesh, then transferred to a long retention mesh for viewing.

As the name implies, the fast storage mode provides increased storage writing speed. For example, in the reduced scan display mode, the variable persistence writing speed of 5.4 cm/μs is increased to 2500 cm/μs by selecting fast variable persistence. The 2500 cm/μs writing speed is fast enough to capture a single event equivalent to the 7834's 400 MHz bandwidth or a 900 ps rise time.

400 MHz Dual-Beam

Dual-beam oscilloscopes are essentially two oscilloscopes in one. Each beam operates separately and independently of the other. They are required for many applications where two transient events must be compared simultaneously. These application areas include stimulation and reaction events in such fields as medicine, biology, chemistry, engineering mechanics, to name just a few.

Depending on the plug-ins selected, up to eight traces can be displayed at a time.

Digital Measurement Plug-ins

The 7000 Series Digital Plug-ins include: a universal counter/timer, digital multimeter with temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special readout unit to label each test for future reference. Together with a 7000 Series Mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital techniques.

This combination offers many advantages over separate test units. You get: scope-controlled digital measurements, measuring convenience and confidence, increased accuracy, easier and faster solutions to complex problems, a lower dollar investment, more bench space and signal conditioning.

Sampling

The 7000 Series Sampling Plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: a low-cost storage CRT for slow scans, a random mode that lets you see leading edges with pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional displays at the same time on the CRT.

The sampling waveform on the preceding page was displayed using the 7S14. You can position the two bright dots to any two points in a waveform which is displayed at 10 ns/div or faster. The separation between dots is controlled by a calibrated 10 turn DTM dial. Repeated time measurements on similar waveforms may be made more rapidly and accurately and with less fatigue using this unique two-dot method.

Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 60 GHz is provided by the 7L5, 7L13 and 7L18 Spectrum Analyzer. Stable, sensitive and spurious-free, these analyzers work in any 7000 Series Mainframe. The same mainframe may be used with other plug-ins for oscilloscope measurements.

Some plug-in analyzers have microprocessor-aided controls for easy operation, and digital storage and display capability for recalling and comparing signals. Others offer 30 Hz resolution for viewing close-together signals. Some optional tracking generators are available for swept frequency measurements.

Refer to the Spectrum Analyzer section beginning on p. 239 for more information.

7000 Series Reference

7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART*

		PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE							PASSIVE VOLTAGE 50 Ω INPUT COMPT		FET PROBES 50 Ω/1 MΩ INPUT COMPATIBLE			CURRENT PROBES		
PROBE		**P6101 1 Meter**	**P6106 1 Meter P6053B 3.5'**	**P6055 3.5'**	**P6009 9'**	**P6015 10'**	**P6062B 6'**	**P6105 P6108 2 Meter**	**P6056 6'**	**P6057 6'**	**P6202A 2 Meter**	**P6046 6'**	**P6201 6'**	**w/passive term P6021 5' 10 mV/mA**	**w/passive term P6022 5' 10 mV/mA**	**P6302/ AM 503 6'**
FEATURES		**Miniature Probe**	**Fastest Probes Compatible with 1-MΩ Input**	**Adj Attenuation for Differential Use**	**1.5 kV Compatibility**	**40 kV Pk Puise Compatibility**	**Selectable Attenuation**	**Miniature Probe**	**Fastest 10X Passive Probe Low C**	**Fastest 100X Passive Probe Low C**	**10-MΩ Input Impedance Dc, Offset**	**Differential Probe High Cmrr**	**Low Capacitive Loading Ac Coupling Dc Offset**	**Ac High Current**	**Ac High Frequency**	**Dc High Current**
ATTENUATION		**1X**	**10X**	**10X**	**100X**	**1000X**	**Selectable**	**10X**	**10X**	**100X**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**
7104	**7A19**	Nc	Nc	Nc	Nc	Nc	Nc	Nc	500 MHz	480 MHz	300 MHz	100 MHz	430 MHz	Nc	Nc	50 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	350 MHz	350 MHz	300 MHz	100 MHz	310 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz		100 MHz			185 MHz	90 MHz	195 MHz	60 MHz	140 MHz	50 MHz
	7A29	Nc	Nc	Nc	Nc	Nc	Nc	Nc	950 MHz	800 MHz	450 MHz	100 MHz	660 MHz	Nc	Nc	50 MHz
7900 FAMILY	**7A11***	Nc	Nc	Nc	Nc	Nc		Nc						55 MHz	150 MHz	45 MHz
	7A13	34 MHz	105 MHz	65 MHz	85 MHz	65 MHz		75 MHz		105 MHz	105 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		80 MHz	80 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	200 MHz		130 MHz	80 MHz				205 MHz	205 MHz	90 MHz	215 MHz	55 MHz	150 MHz	45 MHz
	7A18	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		75 MHz	75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19	Nc	Nc	Nc	Nc	Nc	Nc	Nc	500 MHz	480 MHz	300 MHz	95 MHz	430 MHz	Nc	Nc	50 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc		Nc	Nc	Nc	Nc	350 MHz	350 MHz	290 MHz	90 MHz	310 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz					185 MHz	85 MHz	180 MHz	55 MHz	140 MHz	45 MHz
7800 FAMILY	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						55 MHz	130 MHz	45 MHz
	7A13	34 MHz	95 MHz	65 MHz	85 MHz	60 MHz		100 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	55 MHz	75 MHz	75 MHz			80 MHz	60 MHz	80 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	160 MHz		110 MHz	75 MHz		100 MHz			170 MHz	85 MHz	165 MHz	55 MHz	130 MHz	45 MHz
	7A18	34 MHz	85 MHz		80 MHz	60 MHz	85 MHz	85 MHz			75 MHz	65 MHz	90 MHz	45 MHz	70 MHz	40 MHz
	7A19	Nc	Nc	Nc	Nc	Nc	Nc	Nc	400 MHz	400 MHz	320 MHz	95 MHz	360 MHz	Nc	Nc	50 MHz
	7A22	1 MHz	Nc	1 MHz	1 MHz	1 MHz	1 MHz	Nc						1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	300 MHz	300 MHz	270 MHz	90 MHz	280 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	145 MHz		105 MHz	75 MHz		100 MHz			150 MHz	85 MHz	155 MHz	55 MHz	125 MHz	45 MHz
7704A	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						55 MHz	125 MHz	45 MHz
	7A13	34 MHz	100 MHz	65 MHz	85 MHz	65 MHz		70 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	40 MHz
	7A15A	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz	70 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	145 MHz		115 MHz	75 MHz		100 MHz			160 MHz	80 MHz	150 MHz	55 MHz	125 MHz	45 MHz
	7A18	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19**	Nc	Nc	Nc	Nc	Nc	Nc	Nc	250 MHz	250 MHz	220 MHz	85 MHz	215 MHz	Nc	Nc	45 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	34 MHz	Nc		Nc	Nc	Nc	Nc	200 MHz	200 MHz	185 MHz	80 MHz	180 MHz	Nc	Nc	45 MHz
	7A26	Nc	140 MHz		105 MHz	75 MHz		100 MHz			160 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
7600 FAMILY	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						50 MHz	85 MHz	40 MHz
	7A13	34 MHz	75 MHz	55 MHz	60 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A15A	34 MHz	60 MHz		55 MHz	50 MHz	60 MHz	60 MHz			65 MHz	50 MHz		40 MHz	60 MHz	35 MHz
	7A16A	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A18	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A26	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz

*Note: The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.

** = Option 09 Mainframe

Nc = Not compatibie

If there is no bandpass specified the probe/plug-in combination is compatibie but not recommended.

RECOMMENDED COMBINATIONS 7000 SERIES MAINFRAMES AND TIME BASES

MAINFRAME		**7104**	**7904 R7903**	**7844/R 7854 7834**	**7704A R7704**	**7603/R**	**7603N Opt 11**	**7633/R 7623A/R**	**7613/R**
Time Base	**PERFORMANCE FEATURE**	● INDICATES RECOMMENDED COMBINATION							
7B50A	Single time base				●	●		●	●
7B53A	Dual time base with mixed sweep					●	● *	●	●
7B53A Opt 05	7B53A with tv sync triggering					●		●	●
7B80	Single time base (used also as delayed time base)		●	●	●				
7B85	Single time base with delaying and Δ delay sweep function		●	●	●(1)				
7B92A	Dual time base with display switching		●	●	●(1)				
7B10	Single time base (used also as delayed time base)	●	●	●	●				
7B15	Single time base with delaying and Δ delay sweep function	●	●	●	●				

1No trace separation on R7704 only.

Following is a list of currently available Application Notes for 7000 Series.

Title	**Featuring**	**Part No.**
ULTRASONIC MEASUREMENTS with digital accuracy	7603/7A22/7D15/7B53A Timing measurements between non-adjacent pulses. Ultrasonic transducers	AX-3681
EASIER, FASTER, MORE ACCURATE Oscilloscope timing measurement	7B85/7B80 Delayed sweep & delta time measurements	A3269
X-Y DISPLAYS with interval timing for measuring S0A	7D15/7A18/7A22 X-Y power dissipation measurements	AX-3959
DAC MEASUREMENTS: The sampling oscilloscope approach	7S14/7D12/M2/7B92A/7904 Measuring DAC (digital analog converter) settling time	AX3632
SCR GATING WAVEFORM MEASUREMENTS with high-resolution digital accuracy	7D12/M2/7A16A (four compartment main frames) SCR measurements. Absolute and relative (two point) voltage monitoring	A-2693

Title	**Featuring**	**Part No.**
DIGITAL INSTRUMENTS combined within Tektronix Oscilloscope give unparalled accuracy and capability	7000 Series digital plug-ins (counter-timers, DVM's, temperatuer probes, sample-hold modules) with application examples.	A-3002
MEASUREMENT VARIETY An Engineering challenge feautring the 7854	7854/WAVEFORM CALCULATOR demonstrating basic operation, application software for percent overshoot, data monitoring and histogram.	AX-4281
GPIB COMMUNICATION with the 7854	7854/4052 and 7854/4924 types of I/O transfers, transmission formats, and operational software in TEK Basic compatible with any 4050 Series calculator	AX-4416

7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER			7A11	7A13	7A15A	7A16A	7A18	7A19	7A22	7A24	7A26	7A29
PAGE			115	114	112	112	113	116	114	116	113	116
PERFORMANCE FEATURE			Low-capacitance FET probe amplifier	Differential dc offset, high-freq cmrr amplifier	Low cost conventional input amplifier	Wide bandwidth conventional input amplifier	Dual-channel amplifier	Wide bandwidth 50 Ω input amplifier	Dc-coupled, high-gain differential amplifier	Dual-channel 50 Ω amplifier	Dual-channel amplifier	Widest Bandwidth Single Channel
MIN DEFL FACTOR			5 mV/div	1 mV/div	5 mV/div (0.5 mV/div)[2]	5 mV/div	5 mV/div	10 mV/div	10 μV/div	5 mV/div	5 mV/div	10 mV/div
ACCURACY[1] WITHOUT PROBE			2% (integral)	1.5%	2%	2%	2%	3%	2%	2%	2%	2%
7100 FAMILY (0°C to 35°C)	7104	BW	250 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	80 MHz	225 MHz	75 MHz	600 MHz	1 MHz ± 10%	400 MHz	200 MHz	1000 MHz
		Tr	1.4 ns	3.5 ns P6053* 3.5 ns P6106** 5.4 ns P6055	4.4 ns	1.6 ns	4.7 ns	0.6 ns	300 ns ± 9%	0.9 ns	1.8 ns	0.38 ns
7900 FAMILY (0°C to 30°C)	7904 R7903 7912AD[3,8]	BW	250 MHz	105 MHz P6053B* 105 MHz P6106** 65 MHz P6055	80 MHz	225 MHz	75 MHz	500 MHz	1 MHz ± 10%	350 MHz	200 MHz	500 MHz
		Tr	1.4 ns	3.4 ns P6053B* 3.4 ns P6106** 5.4 ns P6055	4.4 ns	1.6 ns	4.7 ns	0.8 ns	350 ns ± 9%	1.0 ns	1.8 ns	0.8 ns
		SIG OUT BW	140 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	70 MHz	140 MHz	70 MHz	300 MHz	1 MHz ± 10%	140 MHz	140 MHz	300 MHz
7800 FAMILY (0°C to 35°C)	7844/R	BW	200 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	80 MHz	200 MHz	75 MHz	400 MHz[4]	1 MHz ± 10%	300 MHz	180 MHz	400 MHz
		Tr	1.8 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.4 ns	1.8 ns	4.7 ns	0.9 ns	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns
	7854[7] 7834	BW	200 MHz	95 MHz P6053B* 95 MHz P6106** 65 MHz P6055	80 MHz	200 MHz	75 MHz	400 MHz	1 MHz ± 10%	300 MHz	180 MHz	400 MHz
		Tr	1.8 ns	3.7 ns P6053B* 3.7 ns P6106** 5.4 ns P6055	4.4 ns	1.8 ns	4.7 ns	0.9 ns	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns
7700 FAMILY	7704A Opt 9 (0°C to 30°C)	BW	170 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	170 MHz	75 MHz	250 MHz[5]	1 MHz ± 10%	200 MHz	170 MHz	250 MHz
		Tr	2.1 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.7 ns	2.1 ns	4.7 ns	1.5 ns	350 ns ± 9%	1.8 ns	2.1 ns	1.5 ns
		SIG OUT BW	70 MHz	60 MHz P6053B* 60 MHz P6106** 50 MHz P6055	55 MHz	70 MHz	55 MHz	80 MHz	1 MHz ± 10%	70 MHz	70 MHz	80 MHz
	7704A	BW	170 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	160 MHz	75 MHz	200 MHz	1 MHz ± 10%	200 MHz	150 MHz	200 MHz
		Tr	2.1 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.7 ns	2.2 ns	4.7 ns	1.8 ns	350 ns ± 9%	1.8 ns	2.4 ns	1.8 ns
		SIG OUT BW	70 MHz	60 MHz P6053B* 60 MHz P6106** 50 MHz P6055	55 MHz	70 MHz	55 MHz	80 MHz	1 MHz ± 10%	70 MHz	70 MHz	80 MHz
	R7704	BW	150 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	150 MHz	75 MHz	175 MHz	1 MHz ± 10%	160 MHz	140 MHz	175 MHz
		Tr	2.4 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.7 ns	2.4 ns	4.7 ns	2.0 ns	350 ns ± 9%	2.2 ns	2.5 ns	2.0 ns
		SIG OUT BW	60 MHz	55 MHz P6053B* 55 MHz P6106** 45 MHz P6055	50 MHz	60 MHz	50 MHz	65 MHz	1 MHz ± 10%	60 MHz	60 MHz	65 MHz
7600 FAMILY and STORAGE FAMILY	7603/R 7633/R	BW	100 MHz	75 MHz P6016 55 MHz P6055	65 MHz	100 MHz	75 MHz	100 MHz	1 MHz ± 10%	100 MHz	100 MHz	100 MHz
	7623A/R 7613/R	Tr	3.5 ns	5.0 ns P6016 6.4 ns P6055	5.4 ns	3.5 ns	4.7 ns	3.5 ns	350 ns ± 9%	3.5 ns	3.5 ns	3.5 ns
	7603N11[6]	SIG OUT BW	60 MHz	55 MHz P6016 45 MHz P6055	50 MHz	60 MHz	50 MHz	65 MHz	1 MHz ± 10%	60 MHz	60 MHz	65 MHz
	7612D[8] (0°C to 40°C)	BW	80 MHz	65 MHz	60 MHz	80 MHz	65 MHz	80 MHz	1 MHz ±10%	80 MHz	80 MHz	80 MHz
		Tr (Calculated)	5.0 ns	6.0 ns	6.7 ns	5.0 ns	6.0 ns	5.0 ns	350 ns ±9%	5.0 ns	5.0 ns	5.0 ns

System Environmental Specifications (apply to all instruments except where noted)—Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

[1]Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.

[2]Obtained with 10X gain at reduced bandwidth of 10 MHz.

[3]Refer to Transient Digitizer, 7912AD not available with signal outputs.

[4]Bandwidth is 325 MHz to 10 mV/div.

[5]Bandwidth is 200 MHz at 10 mV/div.

[6]All 7000 Series Plug-ins are compatible with the 7603N11. However, they do not meet the rigid environmental specifications required by the military.

[7]Bandwidth with equivalent time sampling and real time display only.

[8]Fully programmable mainframe. 7A16P Programmable Amplifier recommended. 7A16P provides 200 MHz, 1.8 ns in 7912AD and 80 MHz, 5.0 ns in 7612D, see page 113.

*P6053B has Trace Identify

**P6106 has Ground Reference

DIMENSIONS AND WEIGHTS 7000 SERIES MAINFRAMES AND PLUG-INS

Dimensions		7612D	7912AD	*7854	7104	7904	R7903	7844	R7844	7834	7704A	R7704	7603	R7603	7603NMS	7633, 7623A, 7613	R7633, R7623A, R7613	PLUG-INS SINGLE	PLUG-INS DOUBLE
Height	in	7	7	13.7	13.6	13.5	5.3	12.9	7.0	13.6	13.6	7.0	11.4	5.25	11.5	12.0	5.25	5.0	5.0
	cm	17.8	17.8	34.8	34.5	34.3	13.5	32.8	17.8	34.5	34.5	17.8	29.0	13.3	29.2	30.5	13.3	12.7	12.7
Width	in	19	19	12	12.0	12.0	19.0	12.0	19.0	12.0	12.0	19.0	8.7	19.0	9.7	8.7	19.0	2.8	5.5
	cm	48.3	48.3	30.5	30.5	30.5	48.3	30.5	48.3	30.5	30.5	48.3	22.1	48.3	24.6	21.2	48.3	7.1	14.0
Length	in	26.75	26.75	24.7	23.5	23.3	22.8	23.8	24.8	23.2	22.7	22.4	24.0	24.7	25.2	23.5	22.3	14.5	14.5
	cm	67.9	67.9	62.7	59.2	59.2	57.9	60.5	63.0	58.9	57.7	56.9	61.0	62.7	64.0	59.7	56.6	36.8	36.8
Weights (approx)																			
Net	lb	55	50	45	43.6	32	27	36	33	35.5	30	44	30	30	45	30	32	2	9
	kg	25	22.7	20.4	19.8	14.5	12.2	16.3	15.0	16.1	13.6	20.0	13.6	13.6	20.4	13.6	14.5	0.9	4.1
Shipping	lb		72	62	56	44	52	47	63	47	43	77	46	62	72	42	62	5	12
	kg		32.6	28.1	25.4	20	23.6	21.3	28.5	21.3	19.5	35.0	20.8	28.2	32.7	19.0	28.2	2.3	5.4

*7854 Calculator dimensions, Height 2.7 in. (6.9 cm), Width 10.9 in. (27.7 cm), Length 6.5 in. (16.5 cm).

Recommended Cameras and Adapters

OSCILLOSCOPE	RECOMMENDED CAMERA
7904, R7903, 7844, 7854, 7704A	C-53 or C-51
7104, 7633, 7623A, 7613, 7834	C-53
7603, 7603N11S	C-59

C-50 Series Camera Adapter, part number 016-0249-03, included with camera.

For full details see Camera section, page 262.

TEK Lab Cart Model 3

Model 3 Lab Cart accepts all 7000 Series Oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement Instruments, 5000 Series Oscilloscopes, or 400 Series Oscilloscopes.

For full details see SCOPE-MOBILE® Cart section, page 294.

SUMMARIZED CAMERA CHARACTERISTICS

			LENS				FILM BACKS		
CAMERA	RECOMMENDED FOR	PERFORMANCE FEATURES AND BENEFITS	MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3.25 x 4.25 in Polaroid Film except where noted)	ORDINARILY USED	OPTIONAL AND INTERCHANGEABLE	PRICE with back ordinarily used
C-51R	7904, R7903, 7844, 7704A 7854	Fastest writing speed with 0.5 mag lens.	f/1.2	0.5	3.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Roll	Polaroid Pack and 4 x 5 in Graflok	$1630
C-53P	All except 7603 7603N11S	General-purpose with 0.85 mag lens.	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Pack	Polaroid Roll and 4 x 5 in Graflok	$1340
C-59P	7603 7603N11S	General-purpose at low price.	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 in	Polaroid Pack	Polaroid Roll and 4 x 5 in Graflok	$950
C-5C	All	Low cost.	f/16	0.67 or 0.85 selectable	0.02	9.76 x 12.2 cm	Polaroid Pack	None	$425

*Relative light-gathering power.

7000 Series Non-Storage Mainframes

The 7000 Series . . . more than an oscilloscope

7100 Series	**1 GHz**	**page 84**
7900 Series	**500 MHz**	**page 86**
7800 Series	**400 MHz**	**page 88**
7700 Series	**250 MHz**	**page 90**
7600 Series	**100 MHz**	**page 92**

A high performance instrument system begins with the basic oscilloscope building block — the 7000 Series Mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

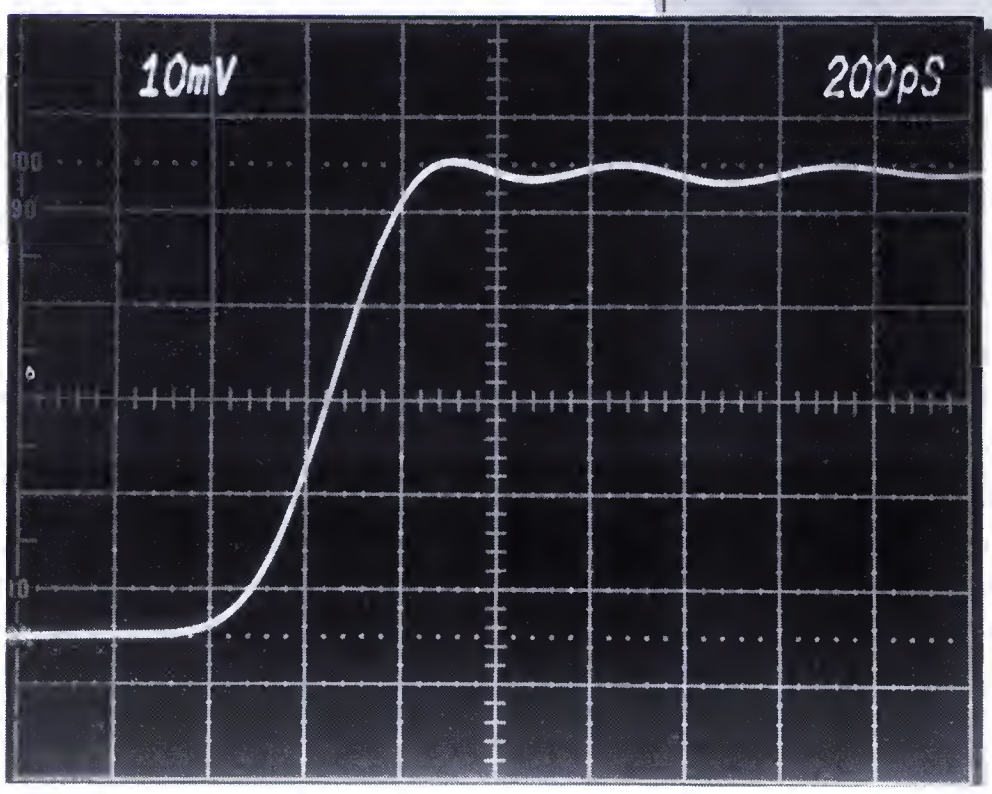
The TEKTRONIX 7104 is a 1 GHz oscilloscope featuring the fastest rise time (350 ps) and writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, dual-beam, alphanumeric displays, rackmounting, and three- or four-plug-in flexibility:

1 GHz General Purpose Oscilloscope

7104

- Outstanding writing speed of 20 cm/ns
- 1 GHz at 10 mV/div
- 200 psec/div fastest calibrated sweep rate
- Horizontal bandwidth 350 MHz
- Phase compensation option—Phase shift <2° from dc to 50 MHz
- CRT Readout
- Compatible plug-ins



The 7104, the widest real time bandwidth, general purpose oscilloscope available today, combines versatility, dependability and exceptional performance.

The 7104 with the 7A29 Amplifier Plug-ins gives you 1 GHz bandwidth at 10 mV per division. This, with the 7B15 or 7B10 Time Base plug-in with a fastest sweep speed of 200 picoseconds per division, lets you now see and measure, for example, the details of overshoot and ringing on the faster digital and laser pulses.

The outstanding writing speed of the microchannel plate crt in the 7104 gives about one thousand times the single shot trace brightness of the previous, non-microchannelplate oscilloscopes. You can see in moderate room light, and easily photograph, the fastest full screen single-shot events. For repetitive signals, even the individual instances of troublesome time jitter and voltage glitch can now be found.

A horizontal bandwidth of 350 MHz, coupled with the option 02 X-Y phase compensation, lets you get accurate X-Y displays of higher speed signals. For example, you can now display the transistor V-I curves for switching power supplies or digital data communication channel phase patterns. When individual amplifier plug-ins are used for X and Y, a triggered time base plug-in can be used to control the Z-axis and blank annoying stationary spots and patterns.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

Vertical Display Modes — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition rate is approx 1 MHz.

Vertical Trace Separation — Operative when any vertical signal is displayed with both A and B time bases. Positions B trace at least 4 div above and below A trace.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with the time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (Except the 7B50A), the 7B70 Series and the 7B92 (non A) are not recommended. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

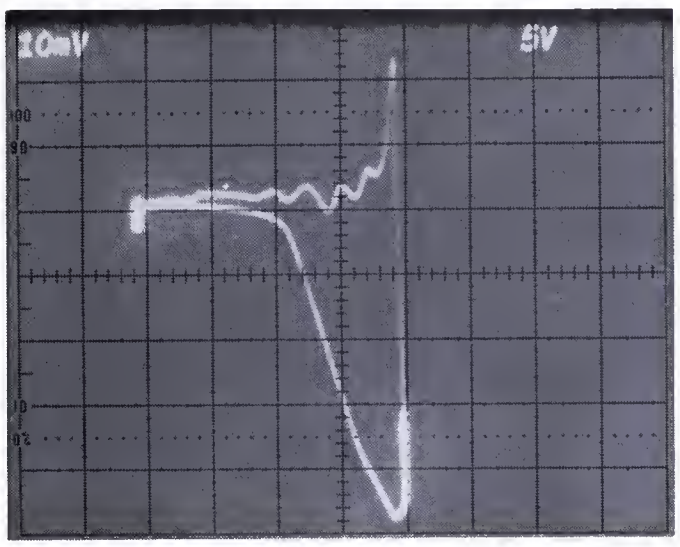
Horizontal Display Modes — A, ALT, CHOP, B.

Fastest Calibrated Sweep Rate — 200 ps/div with the 7B10 or 7B15.

Chopped Mode — Repetition rate is approx 200 kHz.

Bandwidth — Dc to 350 MHz. With delay compensation (7104 Option 02 using 7A19s or 7A29s, at least one of which has the Variable Delay Option, B Horizontal compartment only), within 2° from dc to 50 MHz after adjusting variable delay for balance at 35 MHz. Phase balance can be obtained at any frequency up to 250 MHz. Phase shift is within 2° from dc to 50 kHz without delay compensation.

X-Y Bandwidth: 350 MHz



The transient load line of a fast switching transistor in a power supply prototype (switching time=10 ns) is easily measured for compliance with safe operating area. (Horizontal=V; vertical=I).

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV with P31 Phosphor standard.

Readout and Graticule Modes — Each continuous or pulsed (pulse source selection by front panel controls: +Gate, external, manual). The pulsed graticule is on for approximately 0.5 s.

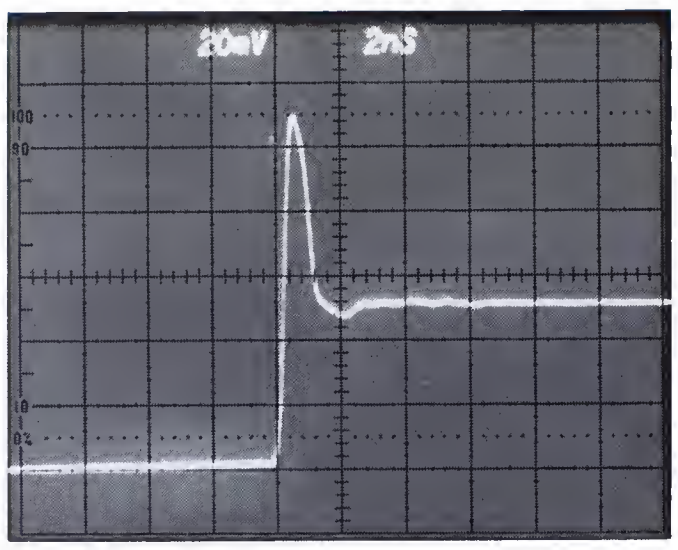
Min Photographic Writing Speed (using Polaroid film type 107, 3000 ASA w/out film fogging) — 20 cm/ns (w/o blue filter). Phosphor: Standard P31. Camera: TEKTRONIX C-53, f/1.9, 1:0.85 lens.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

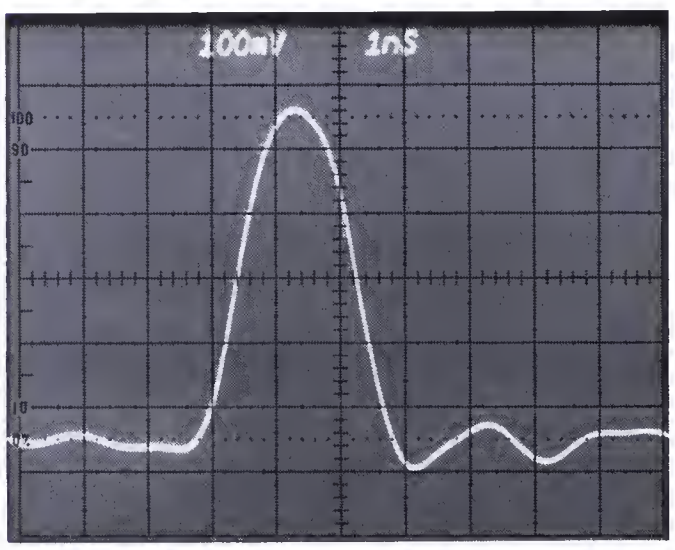
External Z-Axis Input — 2 V p-p for full Intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled. Bandwidth is dc to 1 MHz.

1 GHz at 10 mV/div



Circuit faults such as high frequency pulse overshoot and ringing can easily be observed with the 7104's 1 GHz bandwidth.

Writing Speed: 20 cm/ns



View of a single clocking pulse 0.8 ns rise and 2 ns pulse width.

CALIBRATOR

Voltage Output — Square wave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within .25%.

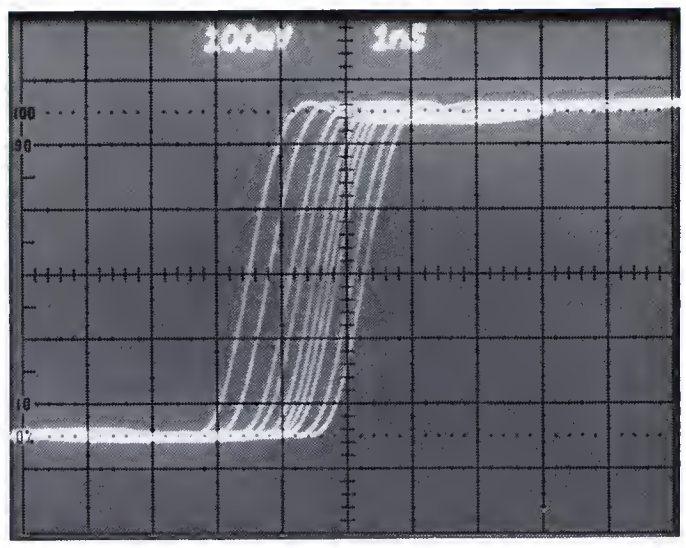
Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

Plug-in Compatibility

Plug-in compatibility. The 7104 is compatible with standard 7000 Series plug-in units.

The 7D01 and 7D02 Logic Analyzers are not designed for use with the 7104 Mainframe. Such use will void the 7104 warranty.

Distinct Image Viewing



A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0 ns jitter when viewed with the distinct image viewing capability of the 7104.

OUTPUTS/INPUTS

+Sawtooth — User selectable from A or B horizontal. Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

+Gate — Positive-going rectangular waveform user selectable from A or B horizontal. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Output R is approx 950 Ω.

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V into 1 MΩ. Bandwidth depends upon vertical plug-in. Output R is approx 950 Ω.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series Camera.

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.

Single-sweep Ready Indicators A and B — +5 V, rear panel BNC outputs for single sweep ready indications.

Graticule/Readout, Single-shot — Ground closure, rear panel BNC input initiates one frame of CRT readout and the GRAT ILLUM is illuminated for approx 0.5 s.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweep.

POWER REQUIREMENTS

Power Requirements — Line voltage ranges, 90 to 132 V ac and 180 to 250 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 215 W, 3.3 A at 90 V line, 60 Hz.

Dimensions and Weights — See page 80.

For Recommended Cameras — See page 81.

For Recommended Plug-ins — See pages 79 and 80.

7104 ORDERING INFORMATION
(Plug-ins not included)

7104 Oscilloscope $17,620

OPTIONS

Option 02 X-Y Horiz Comp. ..... Add $300

Option 03 Emc Modification ..... Add $300

7A29 — Vertical amplifier to bw of mainframe; 10 mV/div to 1 V/div vertical sensitivity.

7B10 — Delayed timebase (similar to 7B80) with 200 ps/div to .2 s/div calibrated sweep speed; triggering up to 1 GHz.

7B15 — Delaying timebase (similar to 7B85) with 200 ps/div to .2 s/div calibrated sweep speed; triggering up to 1 GHz; capable of Δ time measurements in conjunction with 7B10.

500 MHz General Purpose Oscilloscopes

7904
R7903

500 MHz at 10 mV/div

500 ps/div Fastest Calibrated Sweep Rate

Greater than 15 cm/ns Enhanced Writing Speed

CRT Readout

Over 30 Compatible Plug-ins

900 MHz FET Probe Available

7904 and R7903 — VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition rate is approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned 4 divisions above or below the A trace (7904 only).

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series Time Bases. 7B50 Series not recommended.

7904 — HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

Chopped Mode — Repetition rate is approx 200 kHz.

X-Y Mode — Phase shift is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, Option 02) between vertical and horizontal channels. Bandwidth is dc to at least 1 MHz.

R7903 — HORIZONTAL SYSTEM

Single Channel — Right-hand plug-in compartment compatible with time bases of 7B80 and 7B90 Series. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

7904 and R7903
CRT AND DISPLAY FEATURES

Standard — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 Phosphor standard.

Option 01, without CRT Readout — No CRT readout.

Option 04, Max Brightness CRT With Reduced Area — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. P11 Phosphor provides max writing rate. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

Option 78, P11 Phosphor

Option 10, Pulsed Graticule (R7903 Only) — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with crt readout, Option 10 provides additional controls and inputs for crt readout pulsed operation.

The 7904 and 5.25 in rackmount R7903 are the second-widest, real time bandwidth, general-purpose oscilloscopes available today. The 7A19 Amplifier/7904 Mainframe attains 500 MHz at 10 mV. A 7A19 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900 MHz bandwidth by itself, and in combination with the 7A19/7904, it provides a system bandwidth of 450 MHz at 10 mV.

The crt, the major contributor to the performance of the 7904 and R7903, has good visual brightness and an 8 x 10 cm display area. The C-51R Camera, Writing Speed Enhancer, 3,000 ASA film and P11 Phosphor can produce writing speeds up to 9 cm/ns. Speeds up to 15 cm/ns are possible when an optional max-brightness crt with a 4 x 5 cm display area is used.

The R7903 requires only 5.25 in of rack height in a standard 19 in rack. It is fan-cooled and comes complete with slide-out chassis tracks.

Minimum Photographic Writing Speed Using The Optional P11 Phosphor and Polaroid 3000 ASA Film without Film Fogging

CRT	Camera	Lens	Writing Speed cm/ns
Standard 8 x 10 cm	C-51R	f/1.2 1:0.5	2.5
Option 04 4 x 5 cm			4

In typical applications, P31 Phosphor has approximately one-half the writing speed of P11 Phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory) or by using Polaroid 10,000 ASA film or both. The following table lists the approximate relative writing speed gains that can be achieved using these techniques.

Polaroid Film		Relative Writing Speed	
ASA	Types	Without Fogging	With Fogging
3000	107 084 47	1 (reference)	3
10000	410	2	4

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

7904 — CALIBRATOR

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%), dc or B Gate ÷ 2.

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V, 40 V into an open circuit; 2 mV, 20 mV, 0.2 V, 0.4 V into 50 Ω (±1%).

Current Output — 40 mA dc or 1 kHz.

R7903 — CALIBRATOR
(Not Available with Option 10)

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω (±1%).

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

7904 — OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

+GATE — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω; output R is approx 950 Ω.

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in. See the Vertical System Specifications Chart. Output R is approx 950 Ω.

Camera Power — Three-prong connector to the left of the crt provides power, ground, and remote single-sweep reset access for C-50 Series Cameras.

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.

R7903 — OUTPUTS/INPUTS
(Standard)

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

+Gate — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 7 ns or less into 50 Ω. Output R is approx 950 Ω.

Sig Out — Selected by TRIGGER SOURCE switches. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends on the vertical plug-in. See the Vertical System Specifications Chart. Output R is approx 950 Ω.

Single-sweep Ready Indicator — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweep.

CRT Readout, Inhibit — Ground closure, rear panel BNC input locks out CRT readout. Not available with Option 10.

CRT Readout, Single-shot — Ground closure, rear panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single sweep reset access for C-50 Series Cameras.

Probe Power — Two front-panel connectors provide correct operating voltages for two active probes. Not available for R7903 Option 10.

R7903 — OUTPUTS/INPUTS OPTIONS

Option 10, Pulsed Graticule — No CRT readout single-shot input, CRT readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear-panel BNC input is added. Initiates one frame of CRT readout and pulses graticule. CRT readout inputs are not functional with Option 01.

POWER REQUIREMENTS

7904 Power Requirements — Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 190 W, 2.5 A at 115 V line, 60 Hz.

R7903 Power Requirements — Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 160 W, 2 A at 115 V line, 60 Hz.

7904 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); 9 pin cable-mount plug (134-0049-00).

R7903 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); rack-mounting hardware.

Dimensions and Weights — See page 79.

For Recommended Cameras — See page 81.

For Recommended Plug-ins — See pages 79 and 80.

7904 ORDERING INFORMATION
(Plug-ins not Included)

7904 Oscilloscope $7475

7904 OPTIONS

Option 01	without CRT Readout	Sub $300
Option 02	X-Y Horiz Comp	Add $250
Option 03	Emc Modification	Add $300
Option 04	Max Brightness CRT with 4x5 cm display (Specify Phosphor)	Add $500
Option 78	P11 Phosphor	Add $35

7904 CONVERSION KITS

040-0605-03	CRT Readout	$500
040-0606-00	X-Y Horiz Comp	$260
040-0570-00	Emc Modification	$420

R7903 ORDERING INFORMATION
(Plug-ins not Included)

R7903 Oscilloscope $7095

R7903 OPTIONS

Option 01	without CRT Readout	Sub $300
Option 03	Emc Modification	Add $300
Option 04	Max Brightness CRT with 4x5 cm display (Specify Phosphor)	Add $500
Option 10	Pulsed Graticule	Add $150
Option 78	P11 Phosphor	Add $35

R7903 CONVERSION KITS

040-0605-03	CRT Readout	$500
040-0647-00	Emc Modification	$280

400 MHz Dual Beam Oscilloscopes

7844
R7844

- 400 MHz Bandwidth
- Dual Beam
- Full Vertical Crossover Switching
- 8 x 10 cm Display
- CRT Readout
- 1 ns/div Max Calibrated Sweep

The 7844 and 7 inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed crt readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

Display Logic —

	Beam 1	Beam 2
Vertical Compartment Controlling Beam	Left	Left
	Left	Right
	Right	Left
	Right	Right

Vertical Crossover — Permits viewing the same signal on two time bases.

Vertical Trace Separation — Beam 1 can be positioned ±4 cm with respect to Beam 2.

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series Time Bases; not compatible with 7B50 Series.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used. 7B53AN11 requires modification for use in the 7844.

Fastest Calibrated Sweep Rate — 1 ns/div.

X-Y Mode — Phase shift is within 2° from dc to 50 kHz.

Bandwidth — Dc to at least 1 MHz.

Horizontal Separation — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

Display Logic —

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

CRT AND DISPLAY FEATURES

CRT — Dual beam, full overlap. 8 x 10 cm graticule with variable illumination. CRT readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV with P31 phosphor standard.

Option 78, P11 Phosphor.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder (Beam 1 and Beam 2, Independent Controls) — Limits display within graticule area and intensifies beam.

External Z-Axis Input (Beam 1 and Beam 2) — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

Minimum Photographic Writing Speed (Using Polaroid Film without Film Fogging)

1.5 cm/ns using Polaroid 3000 ASA film, C-51R Camera, f/1.2 1:0.5 lens and Optional P11 Phosphor. In typical camera applications, P31 Phosphor has about one-half the writing speed of P11 Phosphor. Writing speed can be increased by using controlled film fogging with a writing speed enhancer, or by using Polaroid 10,000 ASA film or both. The following table lists the approximate relative writing speed gains that can be achieved using these techniques.

Polaroid Film		Relative Writing Speed	
ASA	Types	Without Fogging	With Fogging
3000	107 084 47	1 (reference)	3
10000	410	2	4

The photographic writing speed enhancer, Opt. 22, provides a preset automatic method of film fogging for the 7844. Opt. 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available.

PULSED READOUT AND GRATICULE ILLUMINATION

Provides a means of pulsing the graticule lights or crt readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights or crt readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

CALIBRATOR

Calibrator — Rectangular positive-going waveform from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

Current Output — 40 mA (±1%) rectangular waveshape, front panel current loop 7844, optional current loop adapter (012-0341-00) required for R7844.

OUTPUTS/INPUTS

A and B + Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

A and B + Gate — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is approx 950 Ω.

Single-sweep Ready Indicator — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweeps.

Camera Power — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series Cameras.

Probe Power — Two connectors provide correct operating voltages for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — Selectable 115 V nominal (90-132 V), 230 V nominal (180-264 V).

Line Frequency — 48 to 440 Hz.

Max Power Consumption — 235 W, 2.9 A at 60 Hz 115 V line.

INCLUDED ACCESSORIES

R7844 — 1 rackmount hardware kit, 1 rackmount slide guide (351-0314-00).

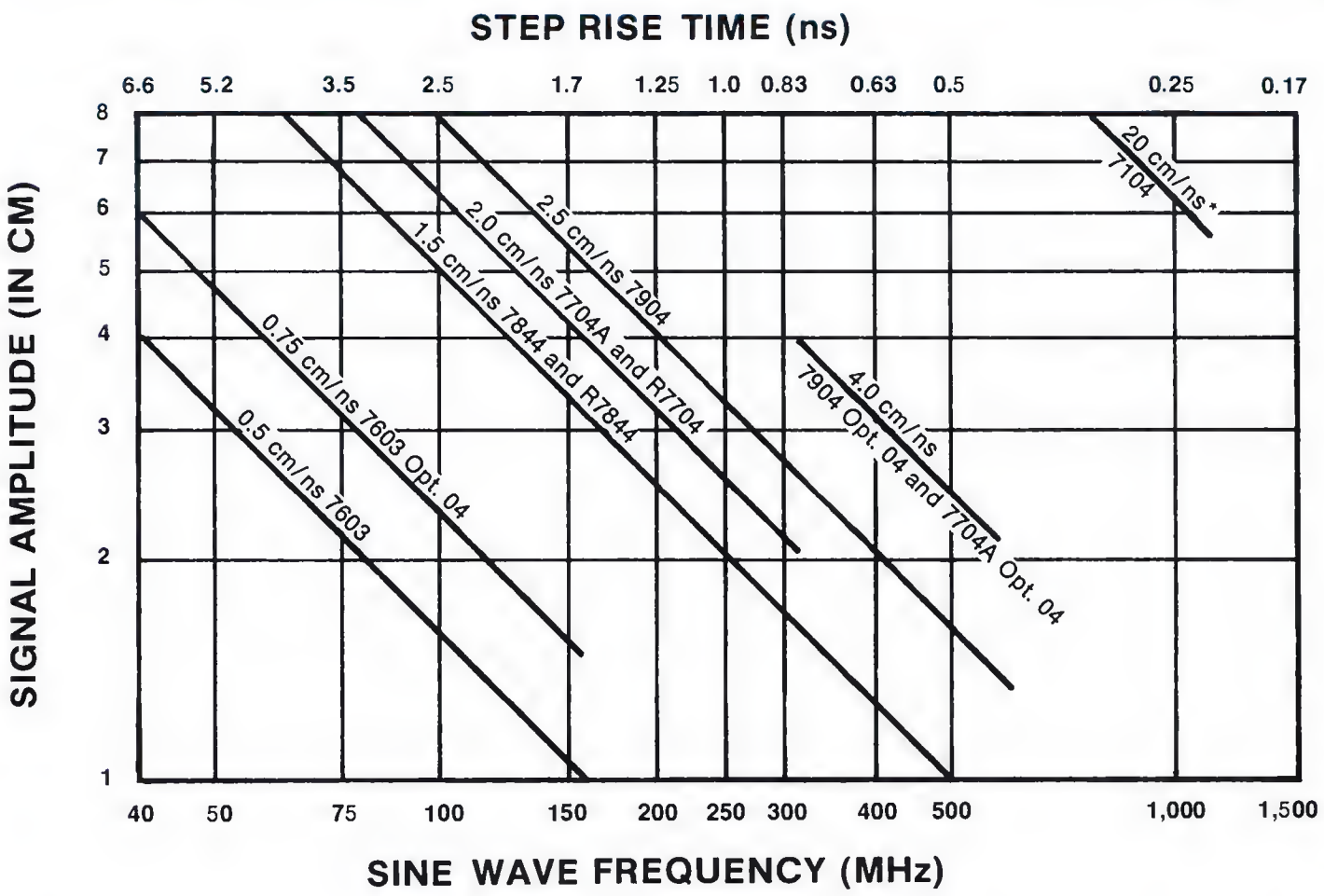
Dimensions and Weights — See page 80.
For Recommended Cameras — See page 81.
For Recommended Plug-ins — See pages 79 and 80.

ORDERING INFORMATION
(Plug-ins not included)

7844 Oscilloscope $11,155
R7844 Oscilloscope $11,555

OPTIONS

Option 03 Emc Modification . . . . . Add $300
Option 22 Writing Speed Enhancer Modification . . . . . Add $400
Option 78 P11 Phosphor . . . . . Add $35



Amplitude vs. speed and photographic writing speed comparison of 7000 Series Mainframes using optional P11 Phosphors, 3000 ASA film and the C-51 (f/1.2, 1:0.5) Camera.

*20 cm/ns is the specified photographic writing speed for the 7104 Mainframe. However, it is not correctly comparable to the other mainframes here because of relaxed phosphor and camera requirements. The microchannel plate crt as well as the brighter photographed image allow for these relaxed requirements. Standard P31 Phosphor is used and a C-53 (f/1.9, 1:0.85 image) Camera.

PHOTOGRAPHIC WRITING RATE

This graph shows the relative photographic writing speed of the 7000 Series Mainframes and the amplitude-speed relationship for each.

Vertical signal amplitude on the vertical scale is shown against maximum sine-wave frequency (lower scale) and fastest rise time (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The step ramp is assumed to be a linear ramp measured between 10% and 90% points.

To obtain these minimum photographic writing speeds, open the camera shutter is before the sweep and leave open for 5 seconds after the sweep. Develop the film for 20 seconds at 25°C. View with front illumination. The limit of photographic writing speed will be a barely discernable trace in the center of the photographic image.

The standard P31 Phosphor has a spectral output that gives about one-half the photographic writing speed of the above optional P11 Phosphor. The visual output of the P31 Phosphor is, however, about six times greater than that of the optional P11.

250 MHz General Purpose Oscilloscope System

7704A
R7704

Dc to 200 MHz with Optimum Pulse Response

Dc to 250 MHz Bandwidth Option

Greater than 15 cm/ns Enhanced Writing Speed with Optional CRT and WSEN

CRT Readout

The 7704 family is a wide bandwidth general-purpose oscilloscope measurement system.

The 7704A Oscilloscope offers you the capability to optimize the oscilloscope's response for your type of work. For pulse analysis, aberrations are reduced below the normal level in the optimized transient response version while still giving you a bandwidth of 200 MHz. The 250 MHz option is optimized for bandwidth performance for high-frequency applications. The R7704 offers a 175 MHz bandwidth.

The 7704A modularity permits the addition of a processing module. With this addition and a Controller, the 7704A is converted into a Digitizer Oscilloscope. This modularity also provides for easy maintenance.

Quite often the need arises to photograph the waveforms that are produced. The 7704A gives you a choice of two designs available for this purpose: the standard 8 x 10 cm CRT and an optional 4 x 5 cm reduced-scan CRT for high writing-speed applications. The standard CRT affords 5.3 cm/ns writing speed (C-51R Camera, P11 Phosphor, and 10,000 ASA film), without enhancement, and 8 cm/ns with the Tektronix Writing Speed Enhancer (WSEN). With the optional CRT and film fogging technique, writing speed can be increased to at least 15 cm/ns. This writing speed reserve means reduced intensity setting for improved trace definition. For additional information on the Writing Speed Enhancer (WSEN) see pages 263 and 266;for a comparison of the 7000 Series writing rate specifications see page 89.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

Option 09 Bandwidth Change (250 MHz) — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper —3 dB) when 7A19 is used. Provides additional performance for those working in this frequency domain.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — 7704A, repetition rate is internally selectable, approx 100 kHz or 1 MHz; R7704, fixed at approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned above or below the A trace.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with all 7000 Series Plug-ins.

Fastest Calibrated Sweep Rate — 2 ns/div with 7B80 or 7B90 Series.

Chopped Mode (between Horizontal Plug-ins) — 7704A, repetition rate is internally selectable, approx 20 kHz or 200 kHz; R7704, fixed at approx 200 kHz.

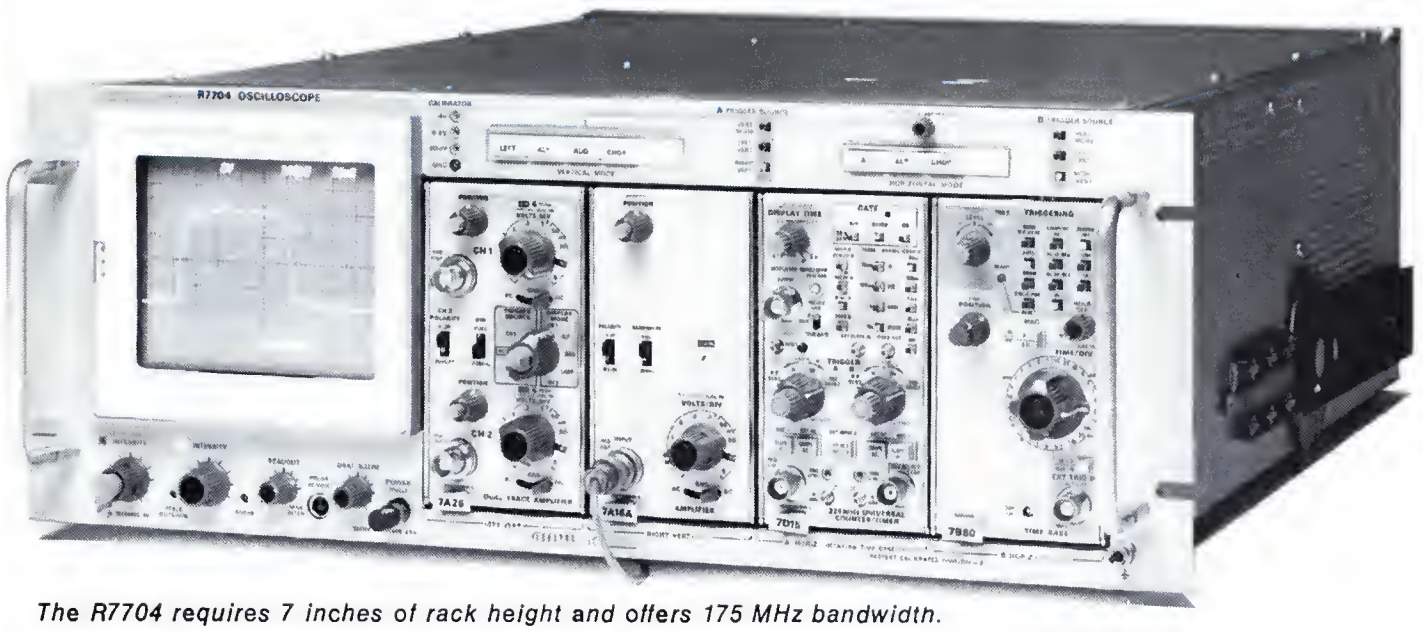
X-Y Mode — Phase shift is within 2° from dc to 50 kHz (7704A), from dc to 35 kHz (R7704) between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

Option 02, X-Y Horizontal Compensation (R7704 only) — Provides phase shift compensation to less than 2° from dc-to-2 MHz.

CRT

Standard — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 Phosphor standard.

Option 01, without CRT Readout — No CRT readout.



The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

Option 04, Max Brightness CRT With Reduced Area (7704A Only) — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 Phosphor standard, P11 optional. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

Option 78, P11 Phosphor

Minimum Photographic Writing Speed (Using Polaroid Film without Film Fogging) — Can be increased by using the Tektronix Writing Speed Enhancer. In typical application, P31 Phosphor has approx one-half the writing speed of P11 Phosphor. See chart on page 86 for further information.

Mainframe	Camera	Lens	Writing Speed cm/ns
7704A R7704 8 x 10 cm	C-51R	f/1.2 1:0.5	2.0
7704A Option 04 4 x 5 cm			4.0

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input (7704A only) — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

External Z-Axis Input (R7704 only) — High sensitivity input: minimum pulse width to blank trace is 30 ns at 2 V; 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace; input R is 500 Ω within 10%. Max input voltage is 15 V (dc + peak ac) and p-p ac.

High Speed Input — Minimum pulse width to blank trace is 3.5 ns at 60 V; 60 V p-p for full intensity range from dc to 100 MHz. A positive signal blanks the trace; input R is 18 kΩ within 20%. Max input voltage is 60 V (dc + peak ac) and p-p ac.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω nominal.

+Gate — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω nominal.

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. The bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart. Output R is 950 Ω nominal.

External Single-sweep Reset — Ground closure, rear-panel input to reset sweep.

Camera Power — Three-prong connector to the left of the crt provides power, ground, and remote single-sweep reset access for the C-50 Series Cameras.

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes. R7704 connectors are located on both the front and rear panels. Probe power is deleted on Option 01 of 7704A.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetion rate is approx 1 kHz.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and gnd pin jacks

POWER REQUIREMENTS

Line Voltage Ranges — 90 to 132 V ac and 180 to 264 V ac.

Line Frequency — 48 to 440 Hz (7704A), 48 to 66 Hz (R7704).

Option 05, Line Frequency Change (50-400 Hz) — Converts the R7704 to 50-400 Hz operation (not required for 7704A).

Max Power Consumption — 180 W, 2.5 A at 115 V line 60 Hz (7704A); 225 W, 2.8 A at 115 V line, 60 Hz (R7704).

Included Accessories — For 7704A: 20 in cable, two-pin-to-BNC, (175-1178-00). For R7704: 42 in BNC 50 Ω cable (012-0057-01); 20 in cable, two-pin-to-BNC (175-1178-00); rackmounting hardware.

Weights and Dimensions — See page 80.

For Recommended Cameras — See page 81.

For Recommended Plug-ins — See pages 79 and 80.

ORDERING INFORMATION
(Plug-ins not Included)

7704A	**Oscilloscope**	**$4220**
R7704	**Oscilloscope**	**$6270**

7704A OPTIONS

Option 01	**Without CRT Readout and Probe Power**	**Sub $300**
Option 03	**Emc Modification**	**Add $300**
Option 04	**Max Brightness CRT with 4x5 cm display (Specify Phosphor)**	**Add $500**
Option 09	**Bandwidth Change (250 MHz)**	**Add $500**
Option 78	**P11 Phosphor**	**Add $35**

R7704 OPTIONS

Option 01	**Without CRT Readout**	**Sub $300**
Option 02	**X-Y Horiz Comp**	**Add $250**
Option 03	**Emc Modification**	**Add $300**
Option 05	**Line Freq Change (50-400 Hz) (not required for 7704A)**	**Add $300**
Option 78	**P11 Phosphor**	**Add $35**

7704A CONVERSION KITS

040-0613-00	**CRT Readout and Probe Power**	**$480**
040-0612-00	**Emc Modification**	**$285**
040-0619-01	**Sig Out/In**	**$125**

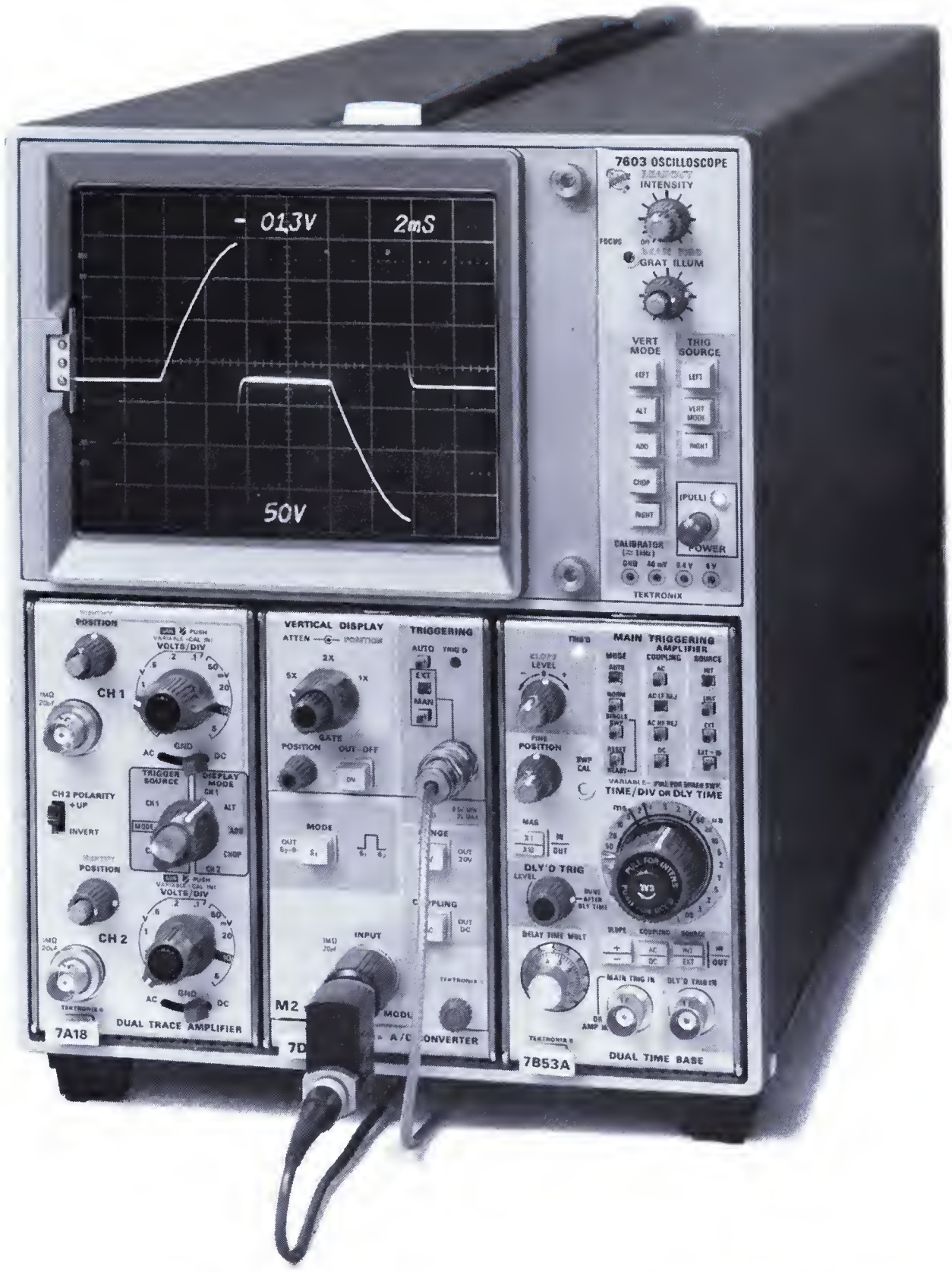
R7704 CONVERSION KITS

040-0533-01	**CRT Readout**	**$480**
040-0529-00	**X-Y Horiz Comp**	**$165**
040-0562-00	**Emc Modification**	**$275**

100 MHz General Purpose Oscilloscopes

7603
R7603

- Dc-to-100 MHz Bandwidth
- 6.5 in CRT
- CRT Readout
- 5.25 in Rackmount



The TEKTRONIX 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100 MHz plug-in oscilloscope market today.

The CRT is large, 8 x 10 div (1.22 cm/div), and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness CRT with a smaller 8 x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels — One right-hand plug-in compartment; compatible with all 7000 Series Plug-ins.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

CRT AND DISPLAY FEATURES

Standard — Internal 8 x 10 div (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV with P31 Phosphor.

Option 01, without CRT Readout — No CRT readout.

Option 04, Max Brightness CRT With Reduced Area — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 18 kV with P31 Phosphor standard.

Option 06, Spectrum Analyzer Graticule.

Optional Phosphors (Specify) — P7, P11, or P7/SA. (Phosphor/Spectrum Analyzer graticule combination.)

Minimum Photographic Writing Speed — Using Polaroid film without film fogging. Can be increased by using the Tektronix Writing Speed Enhancer.

CRT	Writing Speed div/μs				Camera	Lens
	Type 107/47		Type 410			
	P31	P11	P31	P11		
Standard 8 x 10 div (1.22 cm/div)	100	150	200	300	C-50	f/1.9 1:0.7
Option 04 8 x 10 div (1 cm/div)	200	300	400	600		

7603 and R7603 100 MHz Oscilloscopes

The R7603 requires only 5.25 in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been adjusted.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output R is 950 Ω. Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω.

+Gate — Positive pulse of the same duration and coincident with sweep. Output R is 950 Ω. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Rise time is 20 ns or less into 50 Ω. Source is selectable from Main, Delay, or Auxiliary Gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is 950 Ω. Bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart.

External Single-sweep Reset — Ground closure, rear panel BNC provides input to reset sweep.

Single-sweep Ready Indicator — Rear panel BNC provides 5 V for single-sweep ready condition.

CAMERA POWER OUTPUT

Three-prong connector to the left of the crt provides power, ground, and remote single-sweep reset access for the C-50 Series Cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +85°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

Current Output — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and gnd pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50 Hz to 400 Hz (7603); 50 Hz to 60 Hz (R7603).

Option 05, Line Frequency Change (50-400 Hz) — Converts the R7603 to 50-400 Hz operation (not required for 7603).

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan for the R7603.

Included Accessories — (For 7603 and R7603) 20 in cable (two-pin-to-BNC) (175-1178-00); CRT filter (Blue 337-1700-01, Clear 337-1700-04). The R7603 includes rackmounting hardware.

Dimensions and Weights — See page 80.

For Recommended Cameras — See page 81.

For Recommended Plug-Ins — See pages 79 and 80.

ORDERING INFORMATION

(Plug-ins not Included)

7603 Oscilloscope **$2555**

R7603 Oscilloscope **$2955**

7603 OPTIONS

Option 01	Without CRT Readout	Sub $300
Option 03	Emc Modification	Add $300
Option 04	Max Brightness CRT With 8 x 10 cm Display (specify phosphor)	Add $350
Option 06	With Internal Spectrum Analyzer Graticule	Add $50
Option 08	Protective Panel Cover	Add $100

R7603 OPTIONS

Option 01	Without CRT Readout	Sub $300
Option 03	Emc Modification	Add $300
Option 04	Max Brightness CRT With 8 x 10 cm Display (specify phosphor)	Add $350
Option 05	Line Freq Change (50-400 Hz) (not required for 7603)	Add $300
Option 06	With Internal Spectrum Analyzer Graticule	Add $50

7603 CONVERSION KITS

040-0654-02	CRT Readout*	$500
040-0662-01	Emc Modification	$495
040-0629-01	Sig Out/In	$535
040-0686-01	Power Supply to Light Plug-In Pushbuttons	$45
040-0718-00	X-Y Horiz Comp	$370

R7603 CONVERSION KITS

040-0674-02	CRT Readout	$500
040-0679-01	Emc Modification	$275
040-0633-00	Sig Out/In	$275
040-0686-01	Power Supply to Light Plug-In Pushbuttons	$45
040-0718-00	X-Y Horiz Comp	$370

PHOSPHOR OPTIONS (7603/R7603)

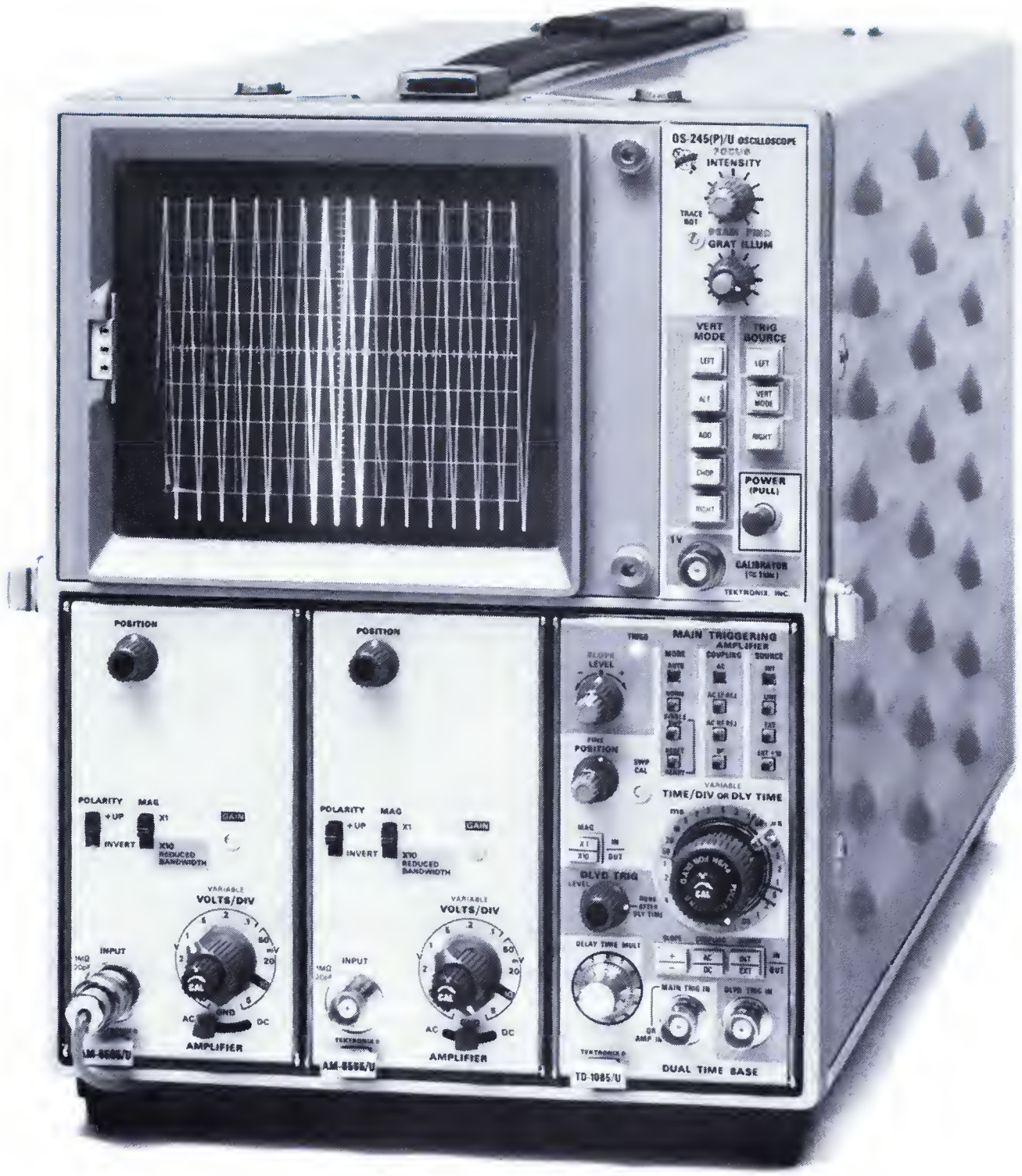
Option 76	P7 Phosphor	Add $35
Option 77	P7 Phosphor with Internal Spectrum Analyzer Graticule	Add $35
Option 78	P11 Phosphor	Add $35

*Not available for 7603N11S.

Ruggedized Oscilloscope System

7603N11S

- Ruggedized for Extreme Environments
- Meets or Exceeds MIL-O-24311 (EC) (AN/USM-281C Specifications)
- Large, Bright Display—6.5 in CRT (15 kV)
- 5 ns/div Delaying Sweep
- 0.5 mV Vertical Sensitivity
- Three-plug-in Flexibility
- Versatile Trigger-source Selection
- Pushbutton Switching
- Illuminated No-Parallax Graticule
- Color-keyed Panels
- Protective Cover with Accessories



The 7603N11S Ruggedized Oscilloscope System meets the rigid environmental and electrical specifications required by MIL-O-24311 (EC) and appears on U.S. Navy QPL-24311. The system consists of a three-plug-in mainframe, two single-trace amplifiers, a dual time base, and a front-panel cover with probes and accessories.

Although the military spec requires only 50 MHz performance, this system actually performs to 65 MHz. Other better-than-required specs include operating altitude, sensitivity at reduced bandwidth with 10X gain, "X" sensitivity in X-Y mode, triggering frequency range, delaying and delayed sweep speeds, and CRT size.

The mainframe and plug-ins are compatible with the TEKTRONIX 7000 Series product line. The system does not have CRT readout, and it can't be used with the digital plug-ins.

ENVIRONMENTAL

Temperature — Non-operating −62° to +75°, operating −28°C to +65°C.

Humidity — 0 to 95% rh over entire temperature range, operating or non-operating.

Altitude — Non-operating sea level to 50,000 ft. operating sea level to 15,000 ft.

Vibration (Operating) — 5 to 15 Hz at 0.060 in ±0.012 in p-p amplitude, 16 to 25 Hz at 0.040 in ±0.008 in p-p amplitude, 26 to 33 Hz at 0.020 in ±0.004 in p-p amplitude.

Shock (Operating) — 9 consecutive 400 pound hammer blows without failure from 1, 3, and 5 ft in vertical, horizontal, and longitudinal axis as per MIL-S-901 for Grade A, Class 1, Type A for lightweight equipment.

Inclination (Operating) — As per MIL-E-16400.

Drip Proof (Non-operating) — As per MIL-STD-198.

Salt Spray (Non-operating) — As per MIL-E-16400.

Electromagnetic Interference — As per MIL-STD-462 performed by MIL-STD-461 for the following tests:

CE-01	30 Hz to 20 kHz	Power lead emission
CE-03	20 kHz to 50 MHz	Power lead emission
CS-01	30 Hz to 50 kHz	Power lead, radiation susceptibility
CS-02	50 kHz to 400 MHz	Power lead, radiation susceptibility
CS-06	Spike Test	Power lead, spike susceptibility
RE-01	30 Hz to 30 kHz	Instrument radiation, magnetic
RE-02	14 kHz to 10 GHz	Instrument radiation, electric
RS-01	30 Hz to 30 kHz	Instrument susceptibility, magnetic
RS-03	14 kHz to 10 GHz	Instrument susceptibility, electric

Reliability — Optimum performance and reliable service are provided during continuous or interrupted operation. The MIL-O-24311(EC) MTBF requirement of greater than 600 hours is met as tested under the following conditions: temperature +40°C ±2°C; relative humidity 70% ±5%; vibration 25 Hz at 0.040 in ±0.008 in p-p amplitude for 10 minutes of each "Power On" hour during each day of the 8 hour manned schedule; power cycled at 4 hour intervals with 10 minutes power off for each 4 hour period of the manned test schedule. An MTBF of greater than 2000 hours was achieved during testing.

VERTICAL SYSTEM
(Includes Two 7A15AN11 Plug-ins)

Channels — Two left-hand plug-in compartments, with a delay line which allows the leading edge of the displayed waveform to be viewed. All 7000 Series Plug-ins are compatible (except those which require CRT readout).

Display Modes — LEFT, ALT, ADD, CHOP, RIGHT. Chopped frequency is approx 1 MHz. Added mode displays signals algebraically with a cmrr of 20:1 to 25 MHz.

Bandwidth/Sensitivity — Dc to 65 MHz from 5 mV/div to 10 V/div, accuracy within 2%, variable extends to 25 V/div. Max sensitivity is 0.5 mV at 10 MHz with 10X gain. Ac-coupling lower -3 dB point is less than 2 Hz. Rise time is 5.4 ns with less than 2% aberrations.

Input R and C — 1 MΩ within 2%, less than 27 pF.

Max Input Voltage — 400 V (dc + peak ac).

Dc Stability — Less than 1 div/hr drift at 25°C.

HORIZONTAL SYSTEM
(Includes One 7B53AN11 Plug-in)

Channels — One right-hand plug-in compartment. All 7000 Series Plug-ins are compatible (except those which require CRT readout).

Internal Trigger Modes — LEFT VERT, VERT MODE, RIGHT VERT.

X-Y Mode — The phase shift between vertical and horizontal channels is less than 2° from dc to 35 kHz. Bandwidth is at least 2 MHz. Rise time is less than 175 ns. Using the 7B53AN11 time-base external amplifier, 10 mV, 100 mV, and 1 V sensitivities (±10%) are available. Input R and C for 7B53AN11 is 1 MΩ within 2%, 20 pF within 2 pF. Any vertical plug-in, such as the 7A15AN11, may be used in the horizontal compartment, providing a greater number of sensitivities for calibrated X-Y displays.

Sweep Display Modes — Main Sweep, Main Sweep Intensified by Delayed Sweep, Delayed Sweep.

MAIN (DELAYING) SWEEP

Sweep Rate — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div fastest calibrated sweep rate, obtained with X10 magnifier. The uncalibrated variable is continuous between steps and to 12.5 s/div.

Sweep Accuracy — Within 3% from 0.05 μs/div to 5 s/div, within 5% at 5 ns/div.

Sweep Modes — Normal, Auto, Single Sweep.

Delay Time — Multiplier range is 0 to 10 times the Time/Div setting. Accuracy is within 1% from 0.5 s/div to 0.5 μs/div, within 2% from 5 s/div to 1 s/div. Incremental linearity is within 0.2% of full scale. Jitter is less than 1 part in 20,000 of 10X time/div setting.

Triggering (Source/Sensitivity) — Internal 0.5 cm to 50 MHz. External, 0.25 V to 20 MHz, 0.5 V to 50 MHz. Ext ÷ 10, 2.5 V to 20 MHz, 5 V to 50 MHz. Triggering extends to 100 MHz with reduced sensitivity in both Internal and External Modes. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; ac lf Rej, 30 kHz to 50 MHz; ac hf Rej, 30 Hz to 50 kHz; dc, dc to 50 MHz. With external level range, slope is ±30 V.

DELAYED SWEEP

Triggering (Source/Sensitivity) — Internal 0.3 div to 10 MHz increasing to 1.5 div at 50 MHz. External, 0.1 V to 10 MHz increasing to 0.5 V at 100 MHz. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; dc 30 Hz to 50 MHz.

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). The delayed sweep runs after delay time or is triggerable after delay time.

Sweep Accuracy — Within 3% from 50 ms/div to 0.5 μs/div, within 4% for all other sweep rates except the magnified X10 sweep rate of 5 ns/div, which is within 6%.

CRT

Accelerating Potential — 15 kV.

Phosphor — P31.

Graticule — Internal 8 x 10 cm with variable illumination. The 6.5 in CRT permits 2 cm of linear overscan in both axes, making a total viewing area of approx 10 x 12 cm.

CRT Controls — Located on front panel are Focus, Intensity, Graticule Illumination, Beam Finder, and Trace Rotation. Astigmatism is an internal control.

External Z-Axis Input (BNC Connector on Rear Panel) — 2 V p-p for full intensity range from dc to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. Max input voltage is 10 V (db + peak ac).

OUTPUTS

Calibrator (BNC Connector on Front Panel) — 1 V within 1%, 1 kHz square wave within 20%.

Horizontal — Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of greater than 50 ns. All amplitudes are minimum and measured when working into at least 100 kΩ and 15 pF.

POWER REQUIREMENTS

Input Voltages — 100, 110, 120, 220, and 240 V ac ± 10% internally selectable with quick-change jumpers with 47.5—440 Hz single phase line frequency. Max power consumption is 125 W.

C281 COVER WITH ACCESSORIES

The cover provides protection during transport and packages the included accessories.

INCLUDED ACCESSORIES
(All Packaged in Cover)

Two P6006 Probe packages (010-0127-00); two 8 ft long 50 Ω BNC cables (012-0366-00); two BNC female to uhf male adapters (103-0015-00); two BNC male to uhf female adapters (103-0032-00); two BNC male to binding post adapters (103-0033-00); two BNC T connectors (103-0030-00). One set of technical manuals (not packaged in cover).

Dimensions and Weights — See page 80.

For Recommended Cameras — See page 81.

ORDERING INFORMATION

7603N11S Oscilloscope System (AN/USM-281C)
7603NMS $6515

System Includes — One each 7603N11 Oscilloscope, two each 7A15AN11 Amplifier Plug-ins, one each 7B53AN11 Time Base, and one each C281 Cover with Accessories.

To Order Separately:

7603N11 Oscilloscope* (OS-245(P)/U) $3350

7A15AN11 Amplifier Plug-in (AM-6565/U)
7A15ANM $700

7B53AN11 Time Base Plug-in (TD-1085/U)
7B53ANM $1700

016-0553-00, C281 Cover W/Accessories $120

*CRT readout not available.

7000 Series Storage Mainframes

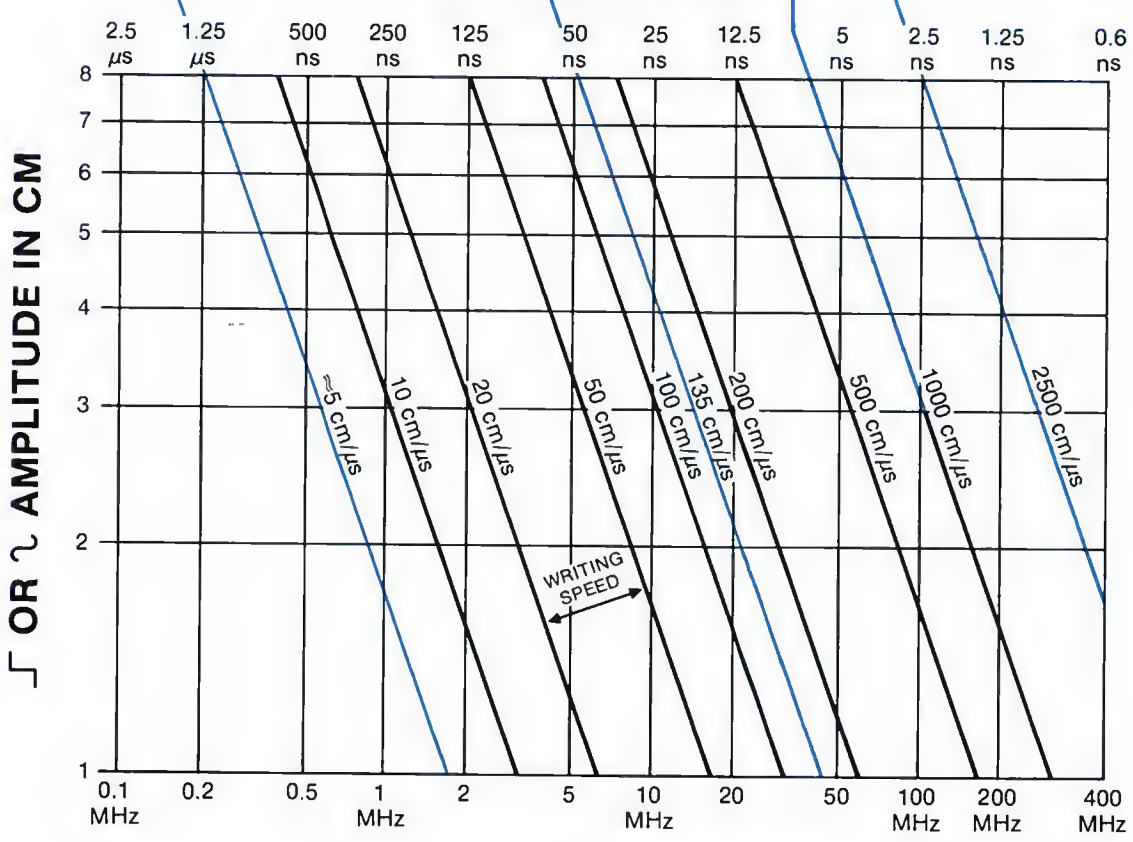
7613
Variable Persistence

7623A
FAST Multimode

7633
FAST Multimode

7834
FAST Multimode

STEP RISE TIME



SINE WAVE FREQUENCY

Graph shows the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≃0.03 cm/µs for mechanical, spectrum analysis, or TDR applications, to 2500 cm/µs for capturing fast single events such as high speed digital logic. A selection of storage modes offers the following features:

Bistable . . . . . Long View Time

Variable Persistence . . . . High Contrast Displays

FAST Bistable . . . Captures Fast Single or Multiple Events

FAST Variable Persistence . . . . Provides Maximum Stored Writing Rate

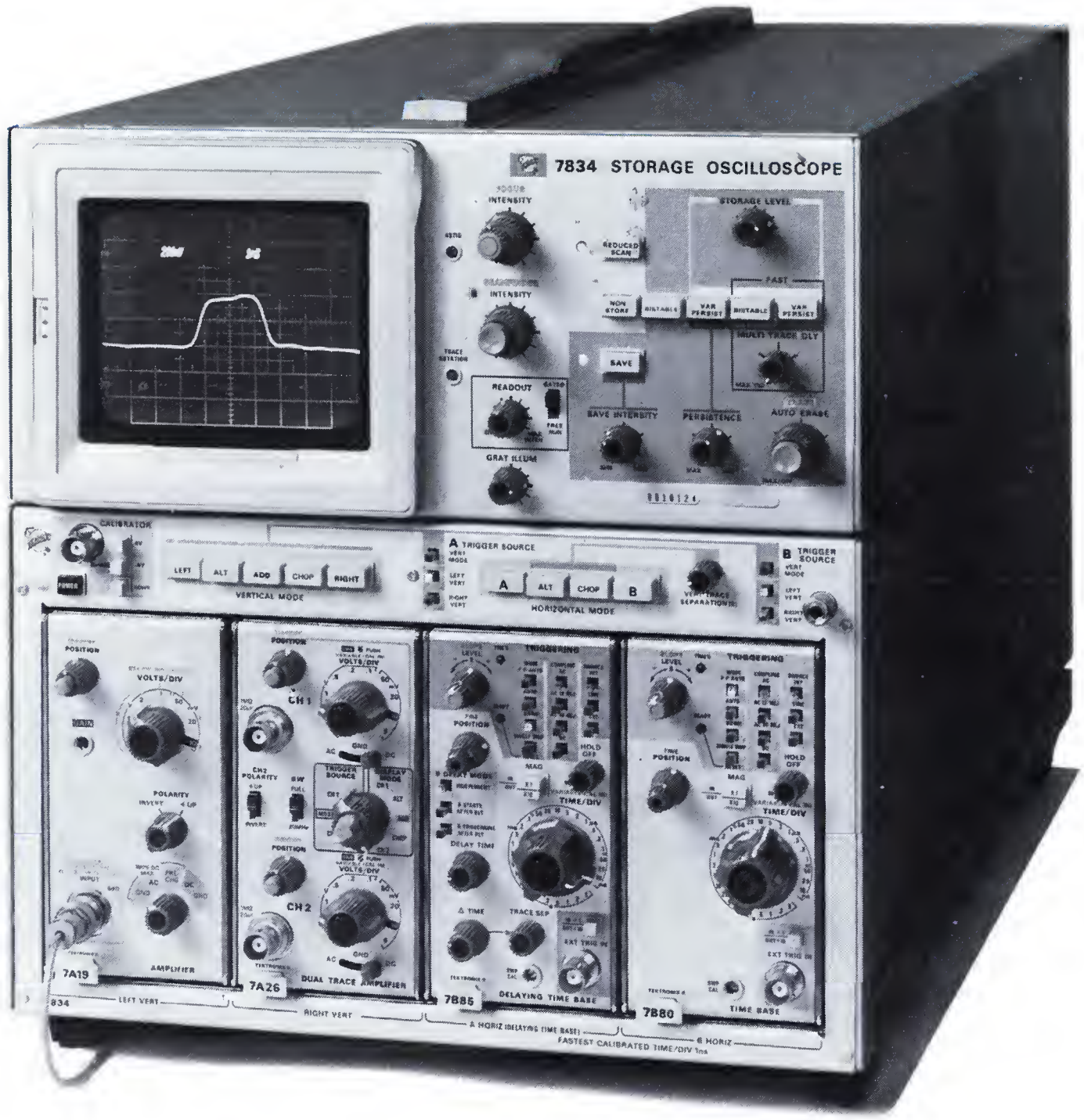
The 7000 Series . . . more than an oscilloscope

7800 Series Storage	400 MHz	page 97
7600 Series Storage	100 MHz	page 99

Fast Storage Oscilloscope

7834

- 2500 cm/μs Stored Writing Speed
- Single-shot Rise Times as Fast as 1.4 ns
- 4 Plug-in Compartments
- Dc-to-400 MHz Bandwidth
- Multimode Storage
- Long View Time



The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/μs, enabling you to capture single-shot rise times to 1.4 ns, 3.5 cm high, at full reduced scan amplitude. The 7834's mainframe bandwidth is 400 MHz (nonstore). The system bandwidth may vary from 160 MHz to 400 MHz depending on the plug-in selected.

This instrument has four storage modes—bistable and variable persistence, FAST bistable and FAST variable persistence.

FAST Variable Persistence provides the maximum stored writing rate of 2500 cm/μs (reduced scan). View time at least 30 s.

FAST Bistable increases bistable writing rates to 350 cm/μs (reduced scan).

Bistable lets you store displays for long periods of time.

Variable Persistence gives you high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, you get continuous bright displays of new information as old information fades from the CRT.

The 4 compartment flexibility lets you perform more than one measurement at the same time without switching plug-ins. The 7834 also offers auto-erase for automatic display updating . . . a save control for 30 times longer viewing . . . gated readout which prevents the blooming that tends to occur between sweeps with nongated readout . . . and an adjustable multitrace delay for varying the viewing time prior to the next sweep in the FAST transfer mode.

The multimode storage unit is designed for single shot, low-rep-rate or fast pulse analysis in laser fusion, digital design and nondestructive component testing applications.

VERTICAL SYSTEM

Input—Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins.

Modes of Operation—LEFT, ALT, ADD, CHOP, RIGHT.

Mainframe Bandwidth—400 MHz with 7A19 Amplifier plug-in (325 MHz at 10 mV).

Mainframe Step Response—0.9 ns or less with 7A19 Amplifier plug-in (1.1 ns at 10 mV).

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

Trace Separation Range—In dual-sweep modes, B trace can be positioned 4 divisions above or below the A trace.

HORIZONTAL SYSTEM

Input—Two right-hand plug-in compartments; compatible with all 7000 Series Plug-ins. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

Modes of Operation—A, ALT, CHOP, B.

Fastest Calibrated Sweep Rate—1 ns/div.

Chopped Mode—Repetition rate is approx 200 kHz.

X-Y Mode—Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

CRT AND DISPLAY FEATURES

Graticule—Internal variable illuminated graticule. 8 x 10 division (0.9 cm/div) graticule in full scan and 8 x 10 division (0.45 cm/div) in reduced scan.

Option 01, without CRT Readout and Probe Power—Deletes CRT readout and probe power.

Accelerating Potential—Approx 10 kV full scan mode, and 12 kV in reduced scan mode.

Phosphor—P31.

CRT Display Modes—Nonstore, Bistable, Variable Persistence, FAST Bistable and FAST Variable Persistence (full and reduced scan).*

Persistence—(Variable Persistence mode only) controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

Auto Erase—Continuously variable from less than 1 s to greater than 10 s.

Multitrace Delay—Adjusts the transfer cycle time in the FAST transfer modes. Continuously variable from less than 1 s to greater than 4 s.

Save—Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in all modes.

External Z-Axis Input—2 V peak-to-peak for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Auto-Focus—Maintains CRT focus following changes in display intensity after focus control has been initially set.

Beam Finder—Limits display within graticule.

Fast Storage Oscilloscope

STORAGE WRITING SPEED

FULL SCAN (Center 6 x 8 div at 0.9 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	270 cm/μs (300 div/μs)	45 cm/μs (50 div/μs)	1.8 cm/μs (2 div/μs)	0.027 cm/μs (.03 div/μs)
View Time	30 s*	30 min	30 s*	30 min
Erase Time (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

*REDUCED SCAN Center 8 x 10 div at 0.45 cm/div

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	2500 cm/μs (5,500 div/μs)	350 cm/μs (776 div/μs)	5.4 cm/μs (12 div/μs)	0.09 cm/μs (0.2 div/μs)
View Time*	30 s	30 min	30 s	30 min
Erase Time* (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

*View times are at full stored display intensity; they may be increased more than 30 times by using reduced intensity in the SAVE display mode.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-Peak Sine wave	Step Response
Reduced Scan 5,500 div/μs (0.45 cm/div)	≥1 ns/div	7.1 div 250 MHz	7.7 div 1.4 ns
		8 div 221 MHz	8 div 1.45 ns
Full Scan 300 div/μs (0.9 cm/div)	≥10 ns/div	3.2 div 30 MHz	3 div 10 ns
		6.4 div 15 MHz	5 div 16.6 ns

OUTPUTS/INPUTS

+Sawtooth—Positive going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is approx 950 Ω.

+Gate—Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is approx 950 Ω. Source is selectable from A Gate, B Gate or A Delayed Gate.

Vertical Signal Out—Selected by A TRIGGER SOURCE switch. Output voltage is 0.5 V into 1 MΩ, 25 mV 50 Ω. Output R is approx 950 Ω. Bandwidth depends upon vertical plug-in.

Remote Single Sweep Reset, Remote Save and Remote Erase—Rear panel BNC connector inputs, ground closure activated.

Remote FAST Transfer Gate—TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

Camera Power Output—Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series Cameras.

CALIBRATOR

Voltage Output—Square wave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within 0.25%.

Current Output—40 mA available through CALIBRATOR output with optional BNC to current loop adapter.

Dimensions and Weight. See page 80.
For Recommended Cameras—See page 82.
For Recommended Plug-ins— See page 80.

POWER REQUIREMENTS

Line Voltage Ranges—90 V-132 V.
180 V-250 V.

Line Frequency—48-440 Hz.

Max Power Consumption—215 watts.

Included Accessories—Gray CRT filter (installed) (378-0625-02) green CRT filter (378-0625-08); power cord (161-0066-00).

ORDERING INFORMATION

(Plug-ins not Included)

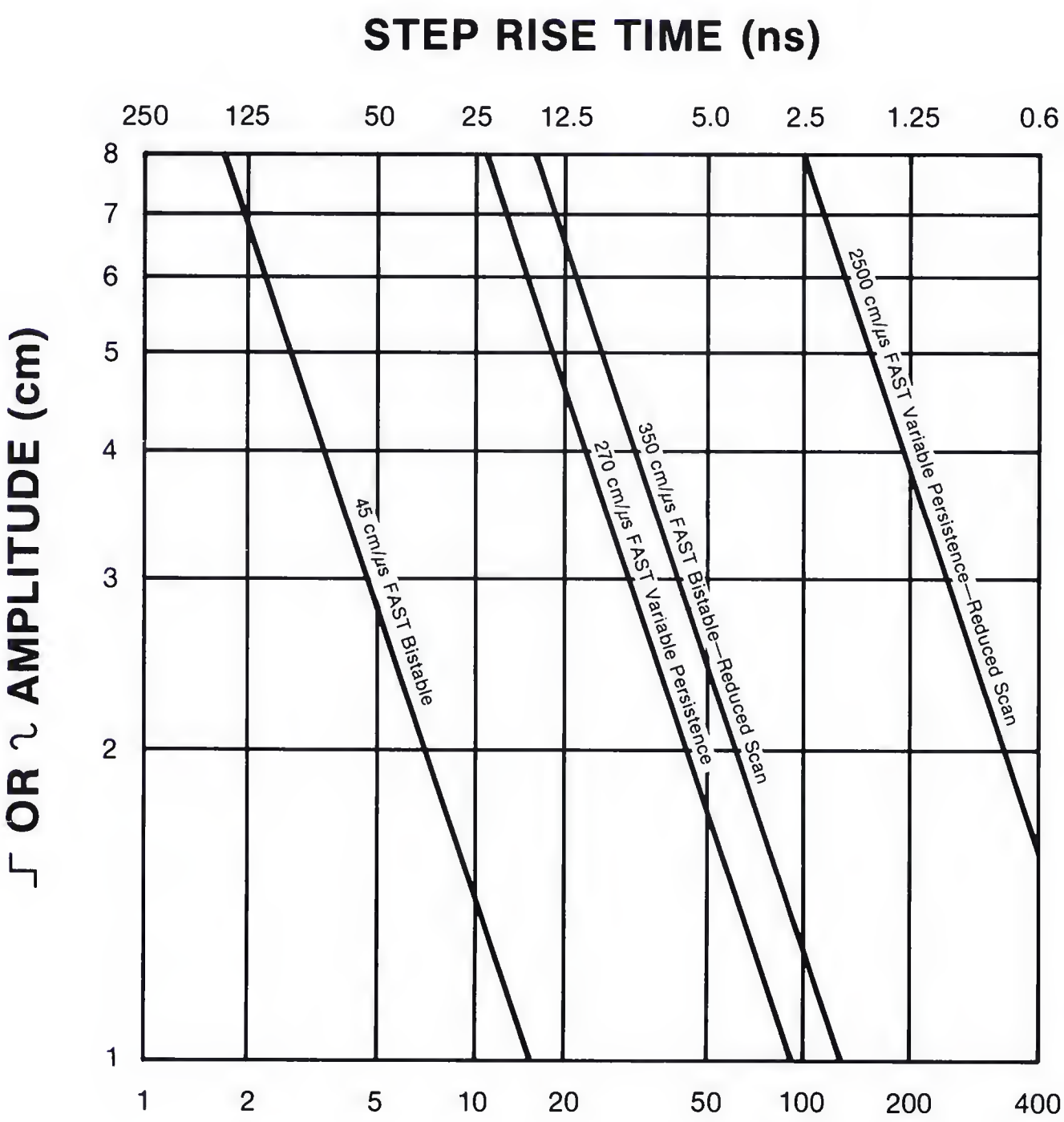
7834 Storage Oscilloscope.....$10,395

OPTIONS

Option 01 without CRT Readout and Probe Power .....Sub $300
Option 02 X-Y Mode Phase Correction.....Add $250
Option 03 Emc Modification.....Add $300
For Rackmounting, order Cradle Mount Adapter 040-0560-00 .....$370

CONVERSION KITS

CRT Readout, Order 040-0811-00.....$480
Emc Modification, Order 040-0880-00.....$435



Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

Multimode Storage Oscilloscopes

7633

1000 cm/μs Stored Writing Speed

Long View Time

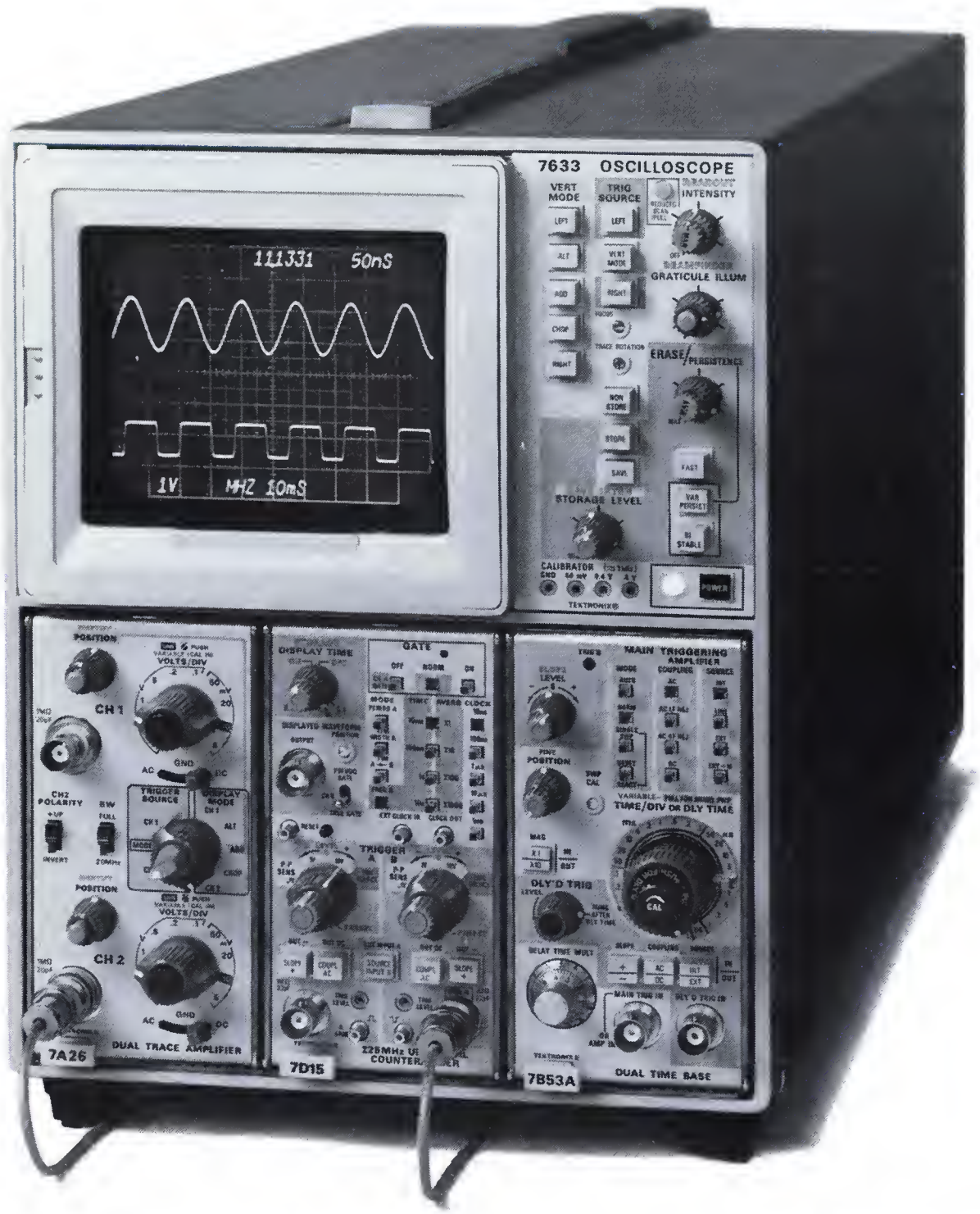
Multimode Storage

Dc-to-100 MHz Bandwidth

The TEKTRONIX 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100 MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The top writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

This multimode storage instrument allows for retention and viewing of fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms. The instrument's capability and versatility make it a problem solver in computer sciences, aerospace, ballistics, communications, and many other fields.

Characteristics are common to the 7633 and the 7623A unless noted.



VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channel — One right-hand plug-in compartment; compatible with all 7000 Series Plug-ins.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is less than 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (0.9 cm/div) and 8 x 10 div (0.45 cm/div) graticule with variable illumination.

Phosphor — P31.

Option 01 — No CRT readout.

Accelerating Potential — Approx 8.5 kV in normal mode, 10 kV in reduced scan mode.

Storage Display Modes — Nonstore, FAST variable persistence, FAST bistable, variable persistence, bistable. Full or reduced scan may be selected on the 7633 In all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

Persistence — Variable. When set to max, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

Autoerase — Variable up to 10 s.

Save — Prevents erasing and storing additional displays; also extends view time in variable persistence mode.

External Z-Axis Input — 2 V p-p for useful intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for calibrated manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

STORAGE WRITING SPEED

Full Scan (7633 and 7623A)

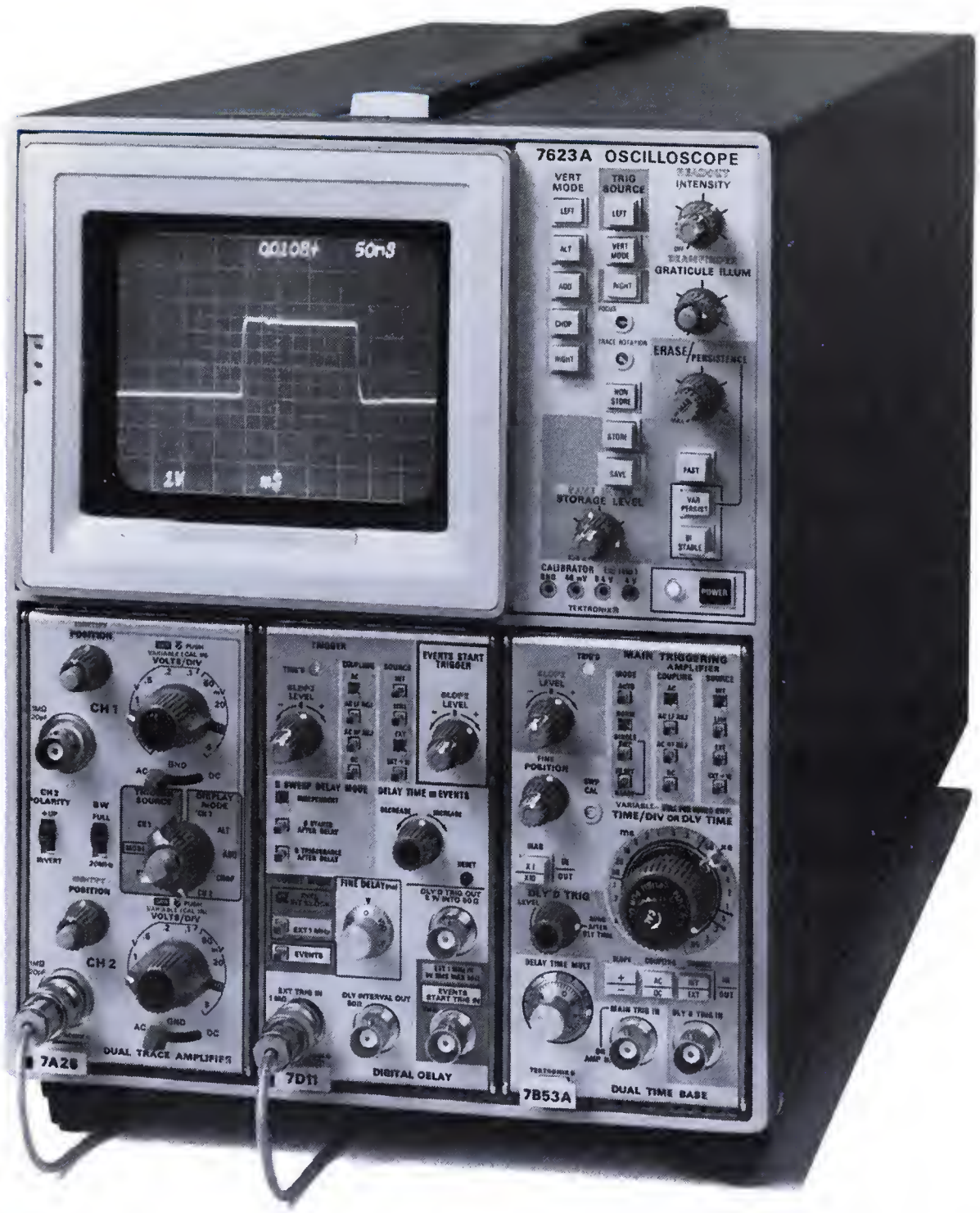
Display Mode	FAST Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/μs	45 cm/μs	0.45 cm/μs	0.027 cm/μs
View Time	30 s*	30 min. minimum	30 s*	30 min. minimum
Erase Time (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

Reduced Scan (7633 Only)

Display Mode	FAST Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	1000 cm/μs	180 cm/μs	1.35 cm/μs	0.09 cm/μs
View Time	30 s*	30 min. minimum	30 s*	30 min. minimum
Erase Time (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

*These times are at full stored display intensity; they may be increased more than 30 times by using reduced intensity in the save display mode.

Multimode Storage Oscilloscopes



7623A

135 cm/μs Stored Writing Speed

Long View Time

Multimode Storage

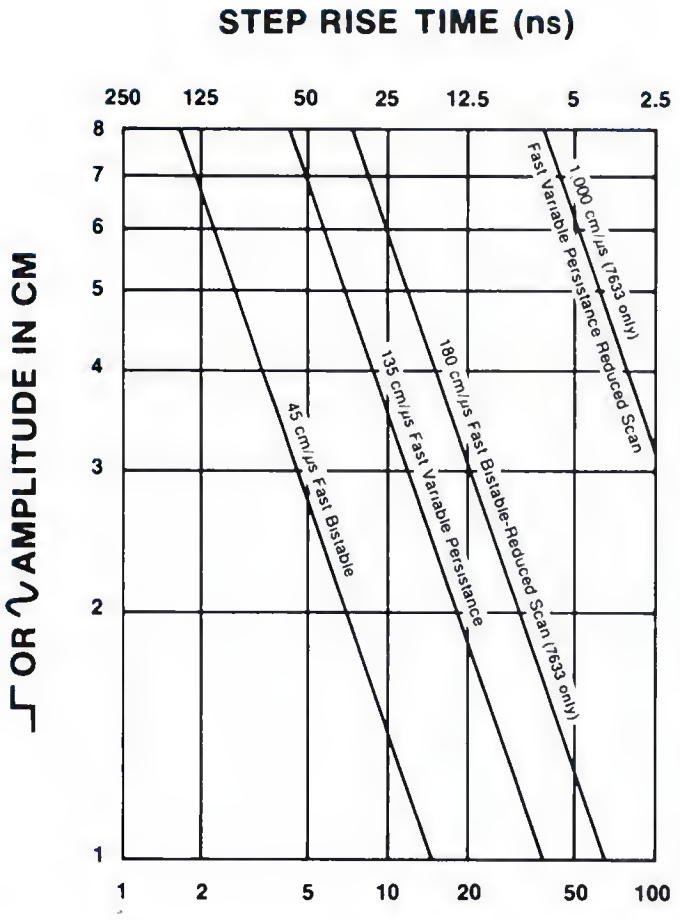
Dc-to-100 MHz Bandwidth

The TEKTRONIX 7623A Storage Oscilloscope has all the features and performance of the 7633 except the reduced scan mode.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-Peak Sine	Step Response
Reduced Scan** 2200 div/μs (0.45 cm/div)	≥5 ns/div	7.1 div 100 MHz	7.7 div 3.5 ns
		8 div 89 MHz	8 div 3.7 ns
Full Scan 150 div/μs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz	3 div 20 ns
		6.4 div 7.5 MHz	5 div 33 ns

**Applies to 7633 only.



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) Into 1 MΩ. Output R Is 950 Ω within 2%.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω, output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Vertical Signal Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series Cameras.

The R7633 and R7623A require only 5.25 In. of rack height in a standard 19 In. rack. They are fan cooled and come complete with slide-out chassis tracks.

Variable Persistence Storage Oscilloscopes

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

Current Output — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and gnd pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50-60 Hz.

Option 05, Line Frequency Change (50-400 Hz) — Converts the 7633 and R7633 to 50-400 Hz operation.

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

Included Accessories — 20 in cable (two-pin-to-BNC) (175-1178-00); CRT filter green (378-0625-08). The R7633 and R7623A include rackmounting hardware.

Weights and Dimensions — See page 82.

For Recommended Cameras — See page 83.

For Recommended Plug-ins — See pages 81 and 82.

ORDERING INFORMATION
(Plug-ins not Included)

7633 Storage Oscilloscope	$6860
R7633 Storage Oscilloscope	$7620
7623A Storage Oscilloscope	$5250
R7623A Storage Oscilloscope	$5650

OPTIONS

Option 01	without CRT Readout	Sub $300
Option 03	Emc Modification	Add $300
Option 05	Line Freq Change (50-400 Hz)	Add $300

CONVERSION KITS

CRT Readout (040-0748-01 Cabinet)	$500
(040-0759-01 Rackmount)	$480
Emc Modification (040-0663-01 Cabinet)	$450
(040-0678-01 Rackmount)	$285
Sig Out/In (040-0629-01 Cabinet)	$535
(040-0633-00 Rackmount)	$275
Power Supply to Light Plug-in Pushbuttons (040-0686-00)	$45

7613

Variable Persistence Storage

4.5 cm/μs Stored Writing Speed

Dc-to-100 MHz Bandwidth

Burn-Resistant CRT

5.25 in Rackmount Height

The TEKTRONIX 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/μs or non-storage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div). The 7613 CRT is burn resistant and doesn't require any special operating precautions.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channel — One right-hand plug-in compartment; compatible with all 7000 Series Plug-ins.

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

Variable Persistence Storage Oscilloscopes

CRT AND DISPLAY FEATURES

Variable Persistence Storage CRT — Internal 8 x 10 div (0.9 cm/div) graticule with variable illumination.

Phosphor — P31.

Option 01 — No CRT readout.

Accelerating Potential — 8.5 kV.

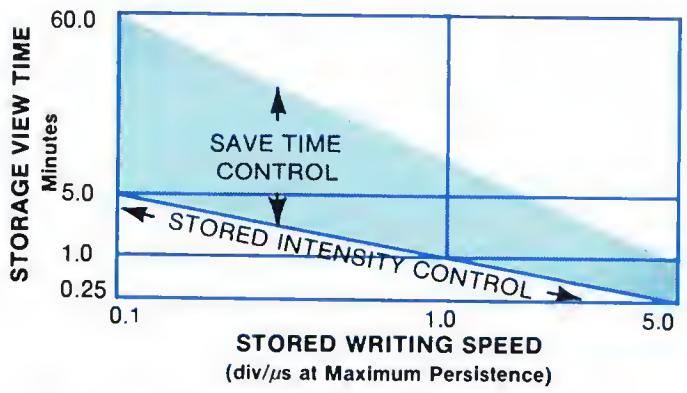
Nonstore Mode — For displaying waveforms in the conventional (nonstorage) mode.

Store Mode — For displaying waveforms using the variable persistence storage feature.

Max Stored Writing Speed — Greater than 4.5 cm/μs.

View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the max writing speed the view time is 15 seconds or 0.25 minutes with the stored intensity control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart below).



Erase Time — 0.5 s or less.

Persistence — The persistence control also varies the view time. The persistence can be adjusted from almost instantaneous disappearance (fade away), to off, which provides the view time selected by the stored intensity control.

Save — Prevents erasure of the stored display and activates the save time control.

Save Time Control — Allows an extension of the view time (see Storage View Time Chart).

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

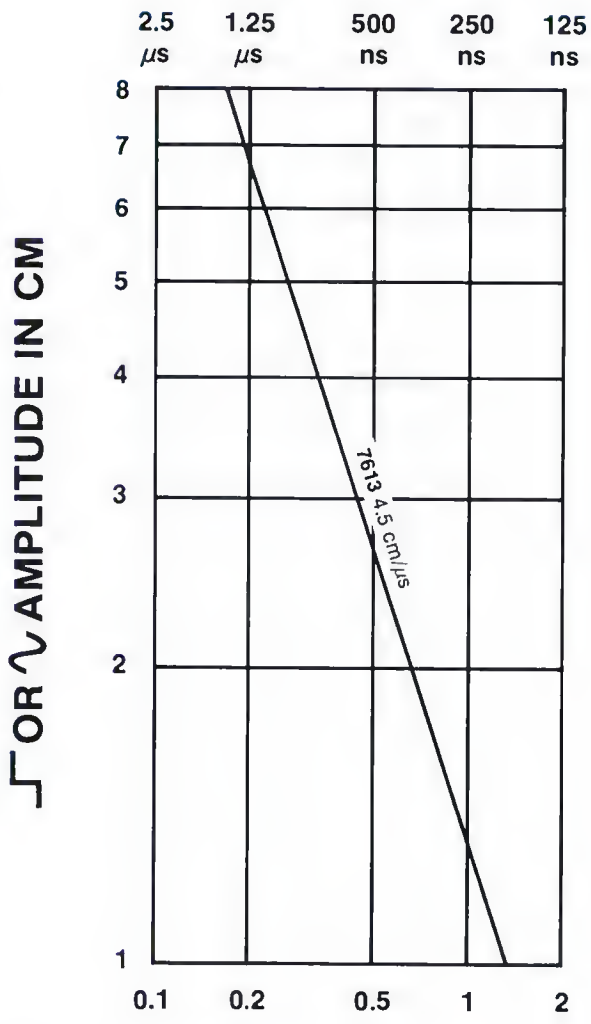
+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

STEP RISE TIME



Graph showing the stored writing speed needed for a given sine wave or step rise time at a given amplitude.

CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series Cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground. (Dc voltage available when selected by internal jumper.) Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetion rate is approx 1 kHz.

Current Output — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and gnd pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50-60 Hz.

Option 05, Line Frequency Change (50-400 Hz) — Converts the 7613 and R7613 to 50-400 Hz operation.

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

Included Accessories (for 7613 and R7613) — 20 in cable (two-pin-to-BNC) (175-1178-00); CRT filter (gray, 378-0625-02). The R7613 includes rackmounting hardware.

Weight and Dimensions — See page 82.

For Recommended Cameras — See page 83.

For Recommended Plug-ins — See pages 81 and 82.

ORDERING INFORMATION
(Plug-ins not Included)

7613 Storage Oscilloscope $4395
R7613 Storage Oscilloscope $4795

7613 OPTIONS

Option 01	without CRT Readout	Sub $300
Option 03	Emc Modification	Add $300
Option 05	Line Freq Change (50-400 Hz)	Add $300
Option 06	Special Int Graticule (Spectrum Analyzer)	Add $50
Option 08	Protective Panel Cover	Add $100

R7613 OPTIONS

Option 01	without CRT Readout	Sub $300
Option 03	Emc Modification	Add $300
Option 05	Line Freq Change (50-400 Hz)	Add $300
Option 06	Special Int Graticule (Spectrum Analyzer)	Add $50

7613 CONVERSION KITS

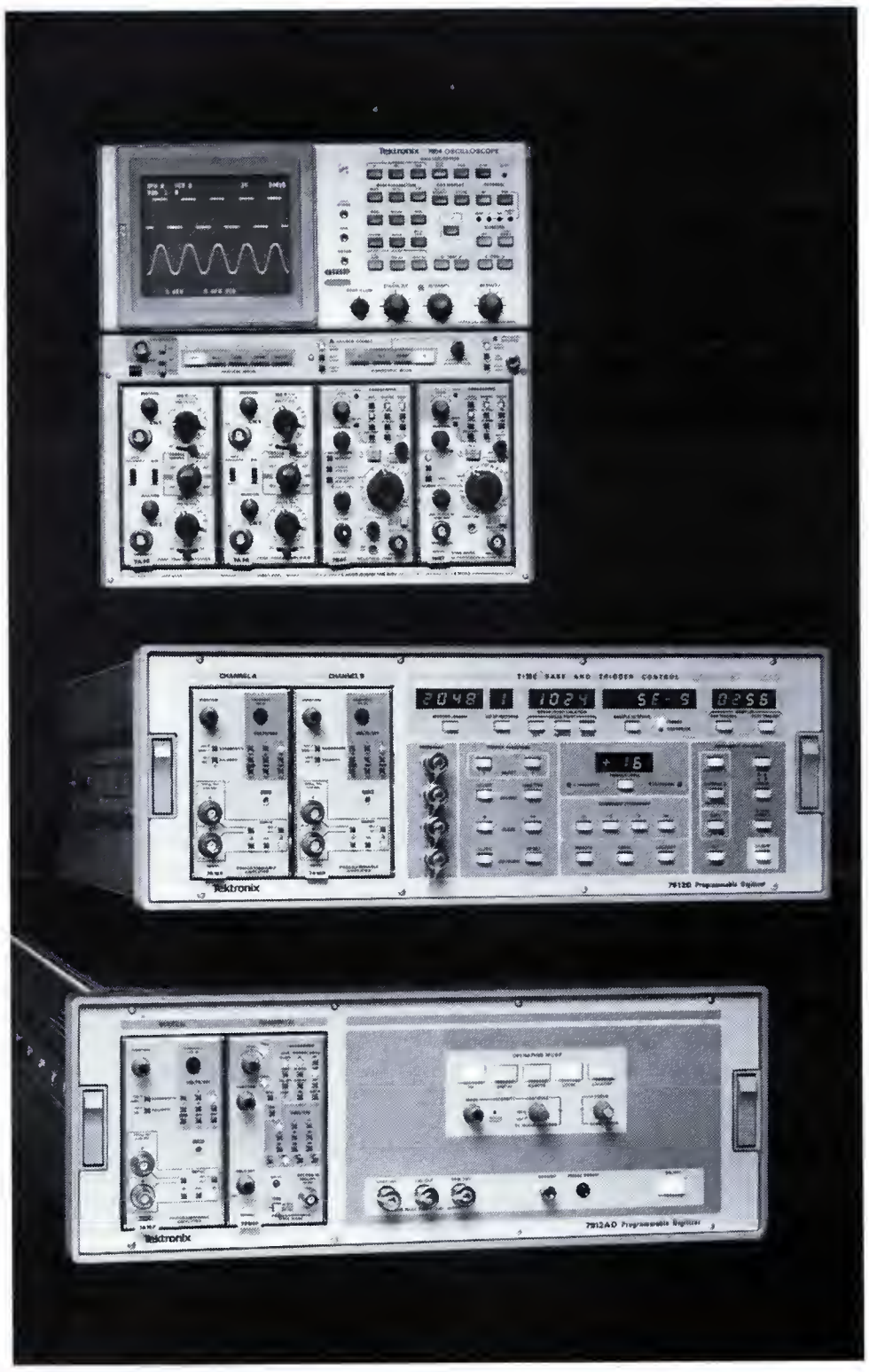
040-0656-02	CRT Readout	$500
040-0663-01	Emc Modification	$450
040-0718-00	X-Y Horizontal Comp	$370
040-0629-01	Sig Out/In	$535
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$45

R7613 CONVERSION KITS

040-0676-02	CRT Readout	$480
040-0678-01	Emc Modification	$285
040-0633-00	Sig Out/In	$275
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$45

The R7613 requires only 5¼ in. of rack height in a standard 19 in. rack. It is fan cooled and comes complete with slide-out chassis tracks.

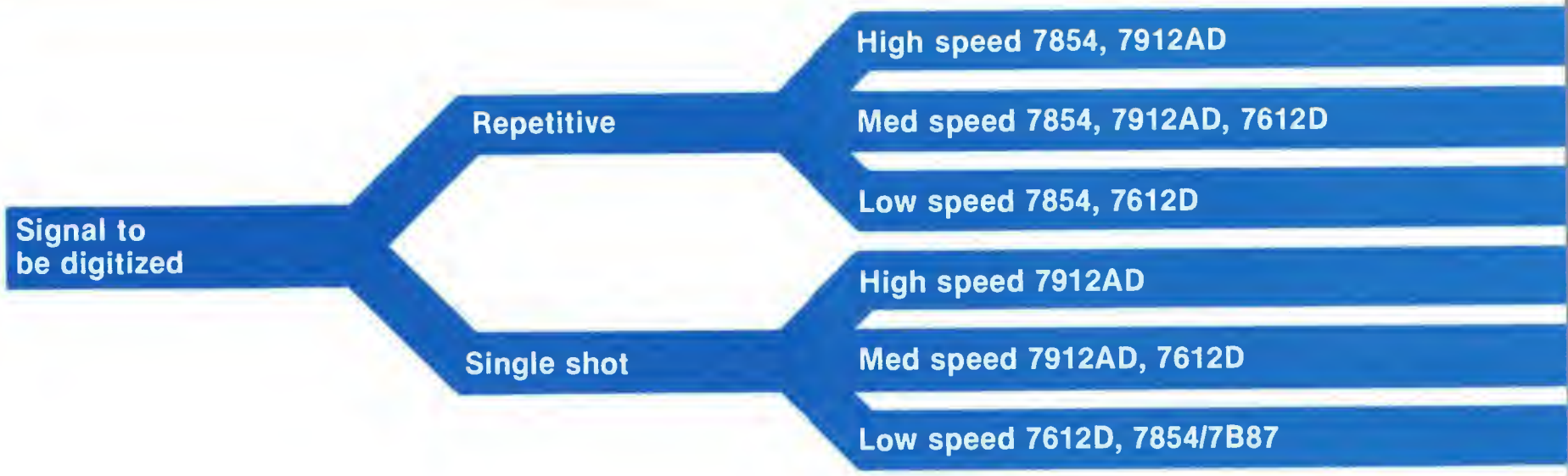
7000 Series Digital Mainframes



GPIB
COMPATIBLE

Especially designed for precise automatic waveform measurements in demanding applications in R&D and production environments.

7000 Series Digital Mainframes offer wide performance capabilities suited to today's demanding measurement needs. Depending on mainframe, capture high or low speed signals that are repetitive or single shot. Configure mainframes to your individual needs from a choice of over 30 plug-ins. The 7854 combines outstanding analog and digital performance with microprocessor-based waveform processing where as the 7612D and 7912AD combine outstanding analog and digital performance with full programmability. All mainframes are fully GPIB compatible.



400 MHz Waveform Processing Oscilloscope

NEW **7854**

- **Waveform Parameters at the Touch of a Key**
- **Dc to 400 MHz Bandwidth @ 10 mV/div**
- **Calibrated Sweep Rates to 500 ps/div**
- **Stores Repetitive Waveforms up to 400 MHz**
- **Single Shot Events up to 50 μs/div (with 7B87 Time Base)**
- **Signal Averaging**
- **Pretrigger (with 7B87 Time Base)**
- **Resolution up to 0.01 div on Stored Data (10 bits)**
- **Choose 128, 256, 512, 1040 Points/Waveform**
- **Keystroke Programming (up to 1000 lines)**
- **GPIB Interface (Standard)**

GPIB Product

The 7854 is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk, Listen.

The 7854 Oscilloscope represents a new approach to waveforms. It displays solutions to common measurement problems on screen at the touch of a button. Now you can concentrate on decision making instead of measurement taking.

The 7854 gives you the features of a Tektronix 7000 Series high performance scope linked with advanced digital storage and waveform processing. It also offers programmable measurement routines, GPIB interface, and compatibility with 7000 Series plug-in units.

The 7854 can display real time and stored waveforms separately or simultaneously. With optional memory up to 40 waveforms can be stored and recalled for easy comparison.

Signal averaging can recover signals buried in noise and improve measurement accuracy. One or two cursors selectable for voltage and time measurements. One cursor provides measurements referenced to ground and time zero, whereas two cursors provide Δ time and Δ voltage. Cursors also bracket areas of the waveform that are to be measured with standard waveform measurement routines; i.e., min, max, p-p.

For single-shot use, the 7B87 Time Base plug-in provides pre-trigger control which allows storage of events that precede the trigger. The amount of pre-trigger data can be varied from 0 to 100%.

The mainframe and calculator keyboards contain a series of buttons representing the most commonly used waveform parameters. These functions operate on stored waveforms. Keystroke programming from the keyboards enable the user to design measurement routines tailored to individual tests or experiments.

7854 SPECIFICATIONS

VERTICAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Mainframe Bandwidth — 400 MHz with 7A29 and 7A19 Amplifier plug-in.

Mainframe Step Response — 0.9 ns or less with 7A29 and 7A19 Amplifier plug-in.

Chopped Mode — Rep. rate is approximately 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform (7B50 Series time bases not recommended for 7854 except 7B50A).

Trace Separation Range — In dual-sweep modes, B trace can be positioned 4 divisions above or below the A trace.

CRT AND DISPLAY FEATURES

CRT Display Modes —
SCOPE (Conventional display.)
STORED (Digital data display.)
BOTH (Stored mode plus real time waveforms.)
PROGRAM ENTRY (User program text display.)

HORIZONTAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.*

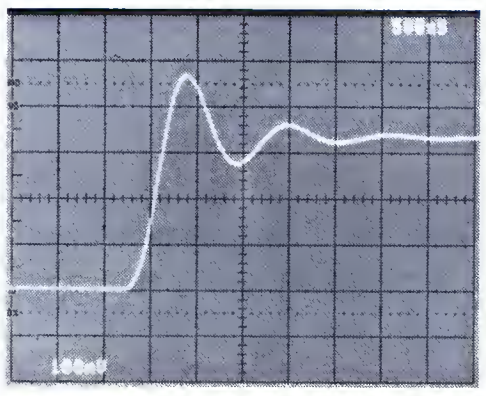
Modes of Operation — A, ALT, CHOP, B.

Fastest Calibrated Sweep Rate — 0.5 ns/div.

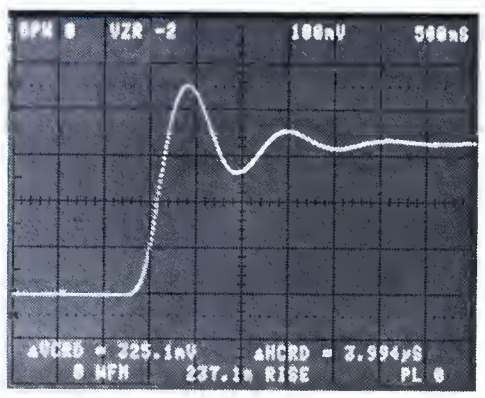
Chopped Mode — Repetition rate is approximately 200 kHz.

X-Y Mode — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction, (dc to 1 MHz with phase correction, B horizontal only, Option 02).

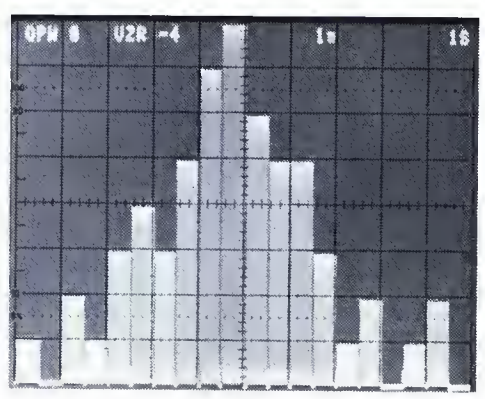
*Note: See plug-in compatibility for exceptions for digital storage.



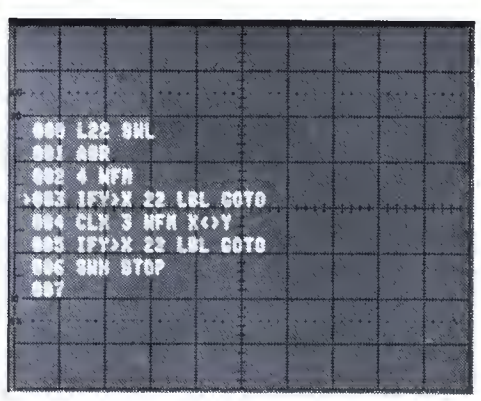
Conventional Scope. In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high performance scopes.



Storage Scope. Rise time is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above rise time.



Multiple Storage and Calculation. Volts, current, and power are all shown on the display. Power (V I) is calculated with two keystrokes.*



Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.

MEMORY FORMAT

	STANDARD				OPTION 2D				OPTION 0D
Points Per Waveform*	128	256	512	1024	128	256	512	1024	512
Max. No. of Waveforms	16	8	4	2	40	20	10	5	1
Max. No. of Constant Registers	50				100				0
Max. No. of Prog. Commands plus lines	920				2000				0

*Unless otherwise selected, default value is 512 at power-up.

PROGRAM STORAGE

Keystroke programming allows the mainframe to remember a sequence of keystrokes (with remote calculator keyboard or GPIB.*)

Editing — Line by line editing capability.

*Note: Vertical and Horizontal mainframe modes and all other keys except edit commands are programmable.

DIGITAL STORAGE

Equivalent Time Bandwidth — 400 MHz. See 7000 Series System bandwidth specifications.

Accuracy — Refer to Plug-in specifications.

Acquisition Channels — One or two simultaneous channels (Plug-in CHOP mode not valid).

Acquisition Window — ±5 divisions from center screen both vertically and horizontally.

Resolution —

Vertical, 0.01 divisions.

Horizontal, selectable points/waveform on remote keyboard only.

Horizontal Resolution (divs)	Points per waveform
0.01	1024
0.02	512
0.04	256
0.08	128

PLUG-IN COMPATIBILITY

All 7000 Series Plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital storage operation. The 7D01, 7D02 and 7T11 are not compatible in STORED mode.

The 7B87 has the same characteristics as the 7B80/7B85 time base plug-ins except for single shot pre-trigger capability. Pre-trigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pre-trigger time is determined by the Acquire-Stop delay time setting. The total amount of pre-trigger is 0.2 to 9.9 times the time/div setting.

Single Shot Performance — Using 7B87 with 7854 Internal Clock.

Fastest Sweep (Time/Div)	Points per waveform
50μs	128
100μs	256
200μs	512
500μs	1024

OUTPUTS/INPUTS

+Sawtooth — Positive-going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is approximately 950 Ω.

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω.

Output R is approximately 950 Ω. Source is selectable from A gate, B gate, or DELAYED gate.

Vertical Signal Out — Selected by a trigger source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is approximately 950 Ω. Bandwith depends upon vertical plug-in.

Remote Single Sweep Reset — Rear Panel BNC, ground closure activated.

TTL Output — Rear panel BNC, TTL output under remote keyboard control (SWH and SWL).

External Z-Axis Input — 2 V peak-to-peak for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Camera Power Output — Three-prong connector to the left on the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series Cameras.

Memory Back-Up Power Input — 6.0 V to 6.5 V at 0.7 amp to preserve stored data if mainframe's power is interrupted.

CALIBRATOR

Voltage Output — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within 0.25%.

Current Output — 40 mA available through Calibrator output with optional BNC to current loop adapter.

POWER REQUIREMENTS

Line Voltage Ranges — 90 V-132 V. 180 V-250 V.

Line Frequency — 48-440 Hz.

Max Power Consumption — 230 W.

Included Accessories — Power Cord (161-0066-00).

BNC-to-BNC Cable — (012-0208-00).

PHYSICAL CHARACTERISTICS

Dimensions and Weights

		in	cm
Mainframe	Height	13.7	34.8
	Width	12.0	30.5
	Length	24.7	62.7
Waveform Calculator	Height	2.7	6.9
	Width	10.9	27.7
	Length	6.5	16.5
	Cord Length	5.6	1.4 (within 7 cm)
		lbs	**kg**
Net Weight		45	20.4
Shipping		62	28.2

IEEE 488 INTERFACE

Standard — Conforms to IEEE 488-1978 standard.

Interface Functions Subset Implemented:

SH1 Complete Source Handshake
AH1 Complete Acceptor Handshake
T5 Talker Function
L3 Listener Function
SR1 Complete Service Request Capability
RL1 Complete Remote/Local Capability
DC1 Complete Device Clear Capability
DT1 Complete Device Trigger Capability

I/O Records — Waveforms constants, program text, and display text.

End of Message Terminator (Selectable in TALK/LISTEN mode for EOI or LF/EOI). — Compatible with Tektronix and other popular controllers.

Device Address — Selectable via rear panel switch.

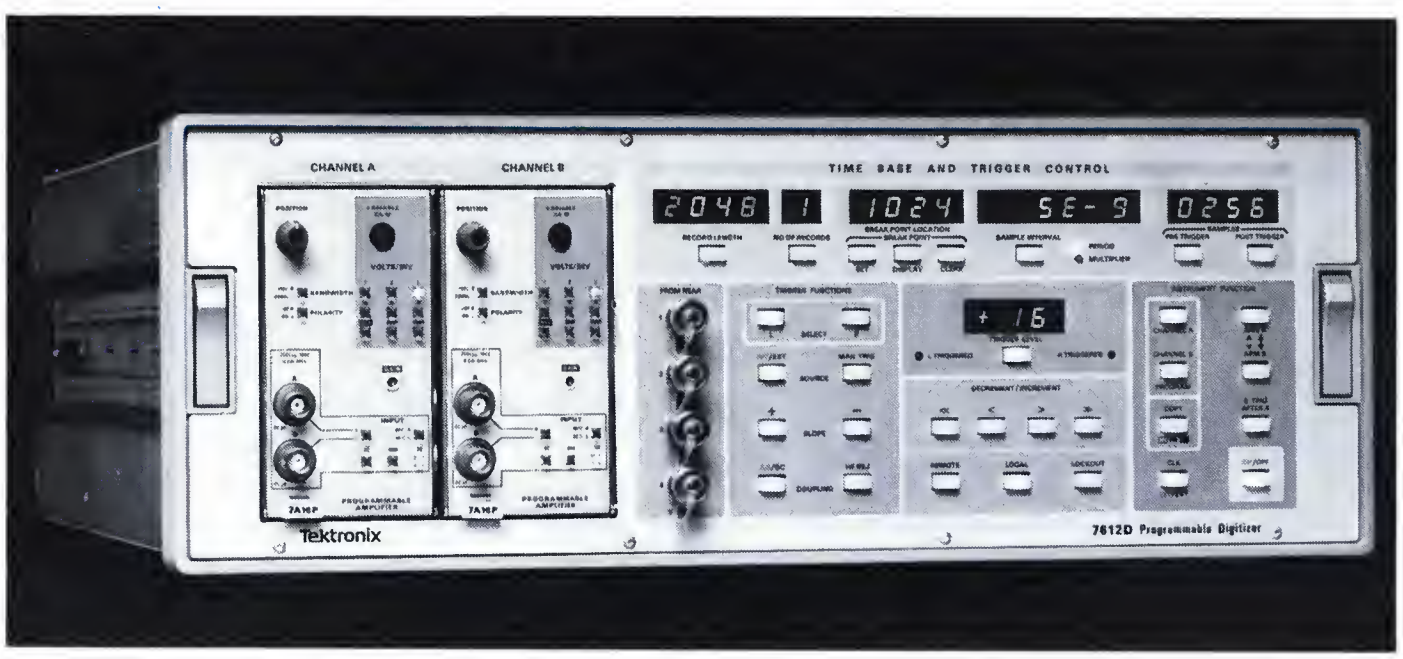
Remote Operation — All keystroke functions and vertical and horizontal modes can be remotely operated via the GPIB.

ORDERING INFORMATION
(Plug-ins not included)

7854 Oscilloscope (including remote calculator keyboard) $10,500
Option 02 (X-Y Phase Correction) . . . . . Add $150
Option 03 (EMC Modification) . . . . . Add $250
Option 78 (P11 Phosphor) . . . . . Add $35
Option OD (Delete GPIB and Remote Keyboard, one waveform storage) . . . . . Sub $500
Option 2D (Expanded Memory, 40 waveform storage) . . . . . Add $1500
Option A1 Universal Euro 220 V/16A . . . . . **No Charge**
Option A2 UK 240 V/13A . . . . . **No Charge**
Option A3 Australian 240 V/10A . . . . . **No Charge**
Option A4 North American 240 V/15A . . . . . **No Charge**
7B87 Time Base required only for pretrigger and single shot digitizing . . . $400

The 7854 is also available as a WP1310 Signal Processing System. This system is a synergistic combination of the Tektronix 7854 Oscilloscope and 4052 Graphic Computer. Together, these two instruments automate the entire waveform test and measurement process, from acquisition and calculation to storage and display formatting.

Programmable Waveform Digitizer



NEW 7612D

- **200 MHz Maximum Sampling Rate**
- **Two Channels, Two Time Bases**
- **8 Bit Resolution**
- **2048 Words of Memory per Channel**
- **5 ns to 1 s Selectable Sampling Intervals with Interval Switching Allowed During Waveform Acquisition**
- **Pretrigger and Posttrigger Operation**
- **Fully Programmable over IEEE 488 Bus For System Oriented Operation**

GPIB Product

The 7612D is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk, Listen.

The 7612D Programmable Digitizer is a dual-channel, dual time base waveform digitizer for use under computer control. It has a maximum sampling rate of 200 MHz. Each channel has its own analog-to-digital converter, a new type designed by Tektronix for accurate, high-speed waveform digitizing. Each channel also has its own time base operating from a single 200 MHz crystal-controlled clock. The result . . . two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time-base settings.

And there's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digtizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. You have the choice, too, of looking at waveforms before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Or you can choose to operate the channels dependently by triggering one after the other.

All 7612D functions can be selected manually or operated under program control over the IEEE 488 bus. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform acquisition function.

Extracting information from medium-speed signals is a typical application of 7612D systems.

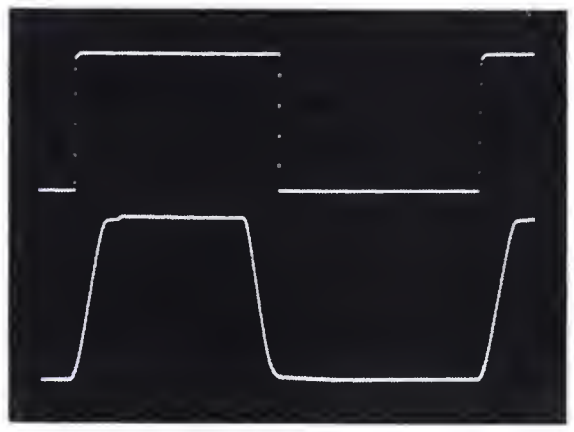


Figure 1. The complete period of a signal (top trace) is recorded at 200 ns; by changing the sample rate to 10 ns during rise and fall times and 800 ns during the plateau (bottom trace),. you can measure rise time, fall time, pulse width and interval accurately on a single shot signal.

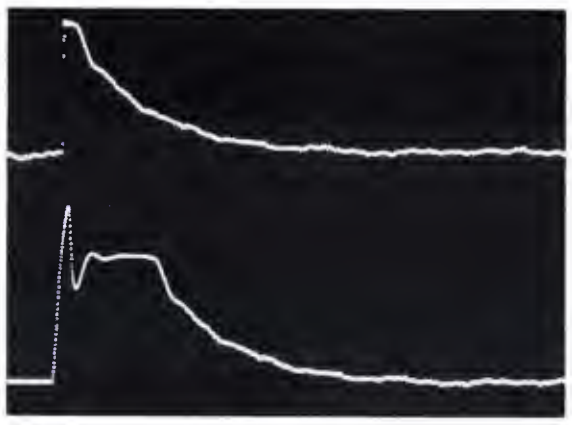


Figure 2. A decaying signal recorded at a 10 µs sampling rate (top trace); the same signal can be recorded at a 100 ns sampling rate during the initial portion and switched back to a 10 µs sampling rate (bottom trace), to capture all information on a single shot signal.

SYSTEMS

The 7612D is also available in WP3000 Series Signal Processing Systems. These fully automatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the second to submicrosecond range. For more information on these systems, contact your local Tektronix Field Engineer.

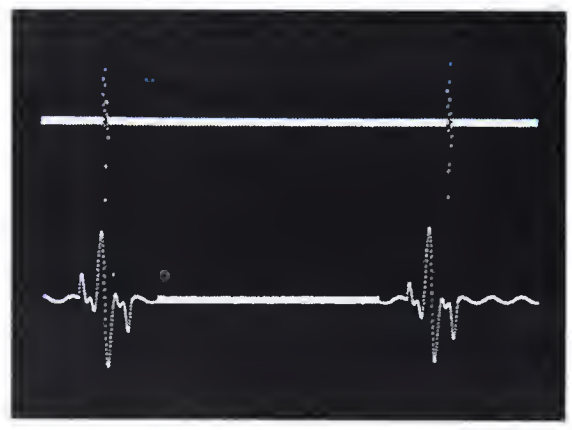


Figure 3. A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.

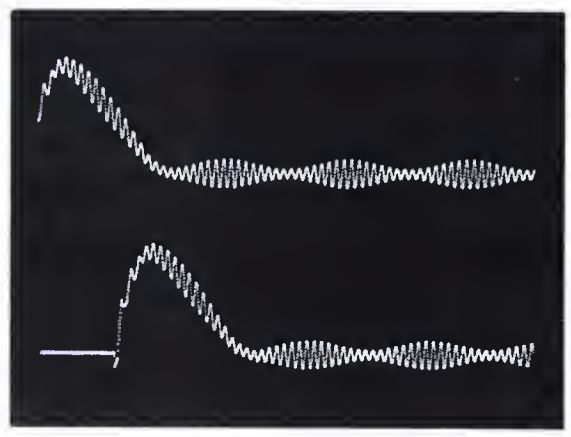


Figure 4. A transient response of a system at power-up recorded with no pre-trigger (top trace); by using the pre-trigger the complete response can be digitized (bottom trace).

Figure 5. The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).

7612D SPECIFICATIONS

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments compatible with all 7000 Series amplifier plug-ins. Fully programmable when 7A16P plug-ins are used.

Bandwidth — 90 MHz. (Mainframe)

Modes of Operation — Left channel with Time Base A and right channel with Time Base B.

TIME BASES A AND B

Type — Two built-in digital time bases with a common crystal-controlled clock.

Clock — Internal: 200 MHz ±0.0035%; stability: of 10 ppm/year. External: from signal source less than or equal to 200 MHz.

Sample Interval — With internal clock: Selectable from 5 ns to 1 s in a 1, 2, 3 . . . 9 sequence (excluding 6, 7, 8 and 9 ns). With external clock: Selectable from 1 to 200 x 10^6 times the external clock period in a 1, 2, 4, 6 . . . 20 sequence.

Interval Switching — Sample interval can be changed up to 13 times per waveform record with preservation of time relationships.

TIME MEASUREMENT ACCURACY

Without sample interval switching: 0.0035% (stability 10 ppm/year). With sample interval switching: 0.0035% (stability 10 ppm/year) for all sample intervals slower than 5 ns.

Modes of Operation — Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

TRIGGERING A AND B

Source — Left or right plug-in, external, manual by push button.

Mode — Single sweep.

Coupling — Ac, dc, ac Hf REJ, dc Hf REJ.

Slope — Positive or negative.

Level Range — Internal: at least ±128 LSB in 256 steps. External: at least ±1.28 V in 256 steps.

Trigger Jitter (Internal) — 0.1 ns or less, dc to 100 MHz.

Triggering Error — ±1 sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).

Trigger Sensitivity —

Coupling	Triggering Frequency Range	Minimum Signal Required	
		Internal	Ext
Ac	40 Hz to 50 MHz	20 LSB	50 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Ac Hf REJ	40 Hz to 50 kHz	20 LSB	50 mV
Dc	dc to 50 MHz	20 LSB	50 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Dc Hf REJ	dc to 50 kHz	20 LSB	50 mV

ARMING A AND B

Push button or computer control.

DIGITIZING AND STORAGE

Method — Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.

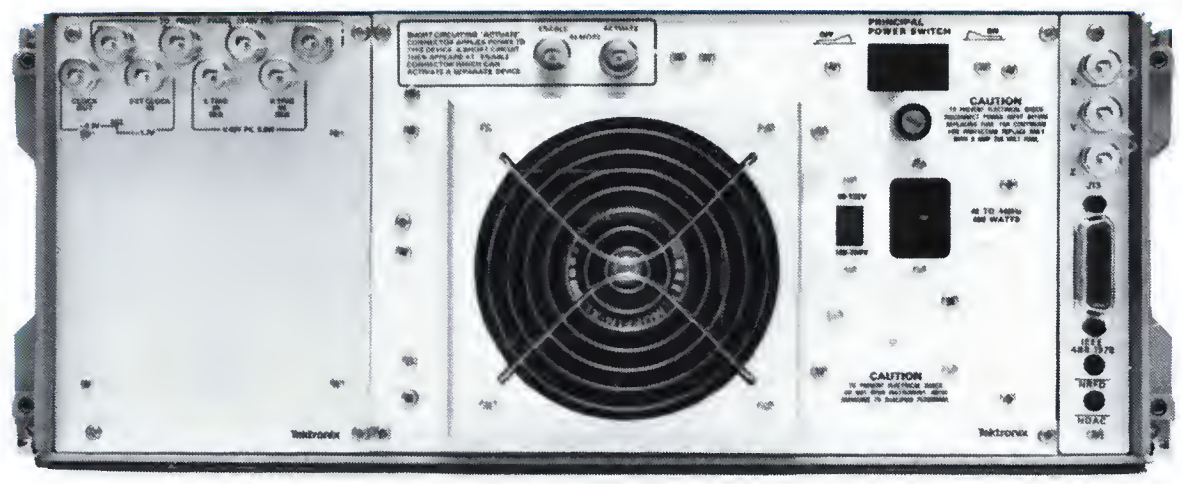
Resolution — 8 bits.

Dynamic Accuracy — Signal to noise ratio and effective bits performance at 25°C for a half scale sine-wave input signal (an ideal 8 bit digitizer would give a S/N ratio of 43.8 dB).

Signal Freq.	S/N Ratio	Effective Bits
300 kHz	42.0	7.8
20 MHz	32.0	6.0
80 MHz	20.0	4.0

Internal Memory — Type: ECL. Size: 2048 8-bit words per channel, total of 4096 8-bit words.

Record Length, A or B — 256, 512, 1024, or 2048 samples. Number of stored records: up to eight 256-word, four 512-word, two 1024-word, or one 2048-word records per channel, each requires a trigger. Trigger Is automatically rearmed after each record acquisition.



7612D rear-panel: the GPIB connector and outputs for an X-Y Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left); remote power ON/OFF is also provided through the two central BNC connectors.

Pretrigger Delay Range — Selectable in multiples of 8 samples. Without sample interval switching: from O up to 16 samples less than the record length. With sample interval switching: from O up to 16 samples less than the position of the first sample interval change.

Posttrigger Delay Range — Selectable in multiples of 8 samples from 8 to the record length (requires selection of only one record).

OUTPUTS/INPUTS

X, Y, Z Analog Output — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V.

Z level is 0 to 1 V (full white) into 100 kΩ or greater.

Clock Out — Provides internal clock signal at ECL level.

External Clock In — ECL levels. Less than or equal to 1 ns rise and fall time. 2.5 ns minimum pulse width and less than or equal to 200 MHz.

L and R TRIG IN. — Provide external trigger input to the left and right trigger channels (50 Ω terminated).

1, 2, 3, 4 — Four feed-through connections to the front panel.

Digital Interface — Conforms to IEEE Standard 488-1978.

IEEE 488 INTERFACE

Standard — Conforms to IEEE 488-1978 standard.

Interface Functions Subset Implemented:

SH 1 Complete source handshake.
AH1 Complete acceptor handshake.
TE6 Extended talker function.
LE4 Extended listener function.
SR 1 Complete service request capability.
RL 1 Complete remote/local function.
PPØ No parallel poll.
DC1 Complete device clear capability.
CØ No controller function.
DTØ No device trigger capability.

Response to Interface Control Messages — The 7612D responds to the following interface control messages:

GTL — Go to local.

LLO — Local lockout.

SDC-DCL — Selected device clear and device clear.

SPE-SPD — Serial poll enable and disable.

IFC — Interface clear.

IEEE 488 Bus Addresses — Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.

Programmable Functions — All instrument settings and operating modes are programmable.

Format — Commands in ASCII, waveform data in binary (range 0 to 377_8).

Transfer rate — 710 K bytes/second maximum.

Waveform Transfer Time — To an infinitely fast controller: 8.35 ms for one 2048 points record. Actual transfer time depends on controller and software speed.

ENVIRONMENTAL

Temperature Range — Operating: 0-40°C. Non-operating: −62°C to +85°C.

Altitude — Operating: −250 to +15,000 feet (−76 to +4570 meters).

Non-operating: −250 to +50,000 feet (−76 to +15,200 meters).

POWER REQUIREMENTS

Line Voltage Range — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48 to 440 Hz.

Power Consumption (including plug-ins) — Maximum 400 watts, 5 A at 115 V 60 Hz.

Remote Control — Remote power ON/OFF capability is provided.

PHYSICAL CHARACTERISTICS

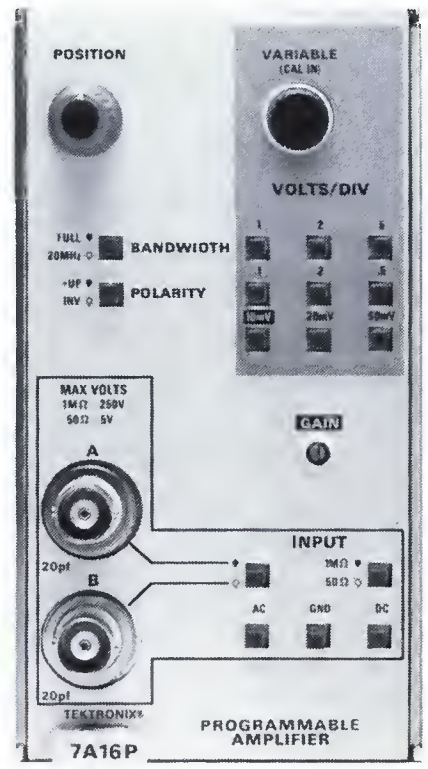
Size — Fits 19 inch rack. Height: 7 in (17.8 cm). Width: 19 in (48.3 cm). Length: 26.75 in (67.9 cm).

Weight — 55 lbs. (25 kg).

STANDARD ACCESSORIES

Operators and Service Manuals, set of rack slides, power cord, IEEE 488 bus cable.

GPIB Product



The 7A16P is a fully programmable vertical amplifier used in the 7612D. For further information, see plug-in specifications in the 7000 Series Plug-in section pages 111-132.

ORDERING INFORMATION

(Plug-ins not included)

7612D Programmable Digitizer $25,700

500 MHz Programmable Waveform Digitizer

7912AD

Digitize and Store Single-Shot or Repetitive Signals from Millisecond to Subnanosecond duration

500 MHz Bandwidth at 10 mV/div

500 ps/div Fastest Calibrated Sweep Rate

Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution

Built-In Signal Averaging Capability

Fully Programmable over IEEE 488 Bus For System Oriented Operation

GPIB Product

The 7912AD is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk, Listen.

Capturing high-speed waveforms is the 7912AD's forte. Each waveform can be sampled up to 512 times within selectable time window ranging from ten milliseconds to five nanoseconds (50 kHz to 100 GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter which writes the signal onto a silicon-diode target array. In TV Mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital Mode the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the IEEE 488 bus to an external controller for processing.

The 7912AD Mainframe is programmable over the same IEEE 488 bus. When the programable plug-ins (one 7A16P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912AD becomes a fully programmable digitizer with a bandwidth of 200 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.

SYSTEMS

The 7912AD is also available in WP2000 Series Signal Processing Systems. These fully automatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the millisecond to nanosecond range. For more information on these systems contact your local Tektronix Field Engineer.

VERTICAL SYSTEM

Channels — Single plug-in compartment accepts any 7000 Series amplifier plug-in. Fully programmable when 7A16P is used.

Bandwidth — Determined by amplifier plug-in. 7A16P: 200 MHz. 7A19: 500 MHz.

Delay Line — Permits viewing of leading edge of acquired waveform.

HORIZONTAL SYSTEM

Channels — Single plug-in compartment accepts any 7000 Series time base. Fully programmable with 7B90P.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B90P or 7B92A Time Bases.

Slowest Recommended Sweep Rate — 1 ms/div In digital mode, possible loss of data below this limit.

DIGITIZING AND STORAGE

Method — Scan conversion.

Resolution — 9 bits. In the Digital Mode, the target is scanned in a 512 x 512 point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV Mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.

Writing Rate (+10°C to +40°C) — TV Mode: writes an 8-div sine wave of at least 500 MHz in a single sweep. Digital Mode: Stores a single 8-div pulse with a rise time of 1 ns or less. Option 04, increases TV Mode writing rate by factor of 2 and Digital Mode writing rate by 2.5.

Target Defects — No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.

Memory — Type: semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples per waveform maximum.

ELECTRONIC GRATICULE

8 x 10 division dot matrix written onto the scan-converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

OUTPUTS/INPUTS

X, Y, Z Analog Output — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 KΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into KΩ or greater.

COMPOSITE VIDEO OUTPUT — Only available in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.

Sync Output — At least 4 V into 75 Ω. Conforms to EIA RS-170.

Sync Loop — Allows TV Mode to be synchronized with external EIA RS-170 sync waveform.

+Gate Output — Provides a positive pulse with a duration equal to and coincident with the time-base sweep.

Z Axis Input — ±1 V input modulates the writing gun intensity over its full range.

Vert. In, Cal. In, Trig. In — Three internal 50 Ω coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rack mounts.

Probe Power — Provides power for Tektronix active probes.

IEEE 488 INTERFACE

Standard — Conforms to IEEE 488-1978 standard.

Interface Functions Subset Implemented:

SH 1	Complete source handshake.
AH1	Complete acceptor handshake.
TE6	Extended talker function.
LE4	Extended listener function.
SR 1	Complete service request capability.
RL 1	Complete remote/local function.
PPØ	No parallel poll.
DC1	Complete device clear capability.
CØ	No controller function.
DT1	Device trigger complete.

ENVIRONMENTAL

Temperature Range — Operating: 0-40°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: Up to 15,000 ft (4 570 m). Nonoperating: Up to 50,000 ft (15 200 m).

EMC (plug-ins inserted) — Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

POWER REQUIREMENTS

Line Voltage Range — 90 V to 132 V ac and 180 V to 250 V ac.

Line Frequency — 48-440 Hz.

Power Consumption (including plug-ins) — 360 watts maximum.

Remote Control — Remote power ON/OFF capabilities provided.

PHYSICAL CHARACTERISTICS

Size — Fits 19 inch rack. Height: 7 in (17.7 cm). Width: 19 in (48.3 cm). Length: 26.8 in (67.9 cm).

Weight — 54.6 lbs (24.7 kg).

STANDARD ACCESSORIES

Power cord, set of rack slides, IEEE 488 bus cable, Operator and Service manuals.

ORDERING INFORMATION

(Plug-ins not included)

It is recommended that 7912ADs not be purchased or operated without an accompanying TEKTRONIX 634 Raster Scan Display Monitor with Option 01 (see pg. 65).

7912AD Programmable Digitizer . . . $23,800

OPTIONS

Option 04 Change to Fast Digitize (changes scanning matrix to 526 x 256 points, changes electronic graticule to mark only every other division, increases writing rate . . . . . No Charge

Option 09 Change Line Voltage (220 V/50 Hz) . . . . . No Charge

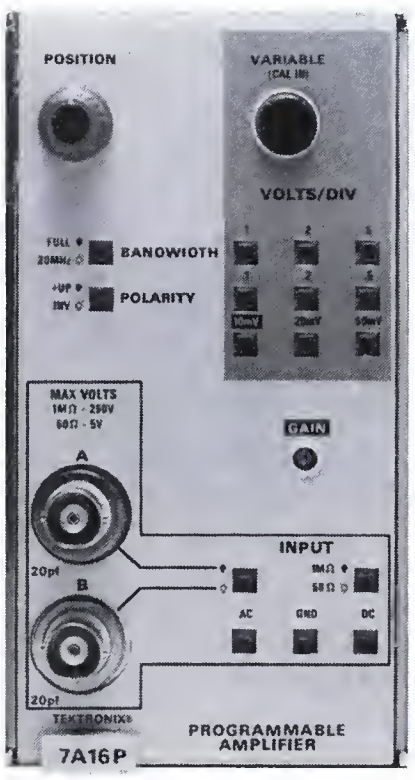
Option 13 Change TV scan to 625 lines at 50 Hz . . . . . No Charge

Option 30 Delete IEEE bus cable . . . . . Sub $90

634 Option 01 Raster Scan Display Monitor $1270

Tektronix offers maintenance training classes on the 7912AD Programmable Digitizer. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

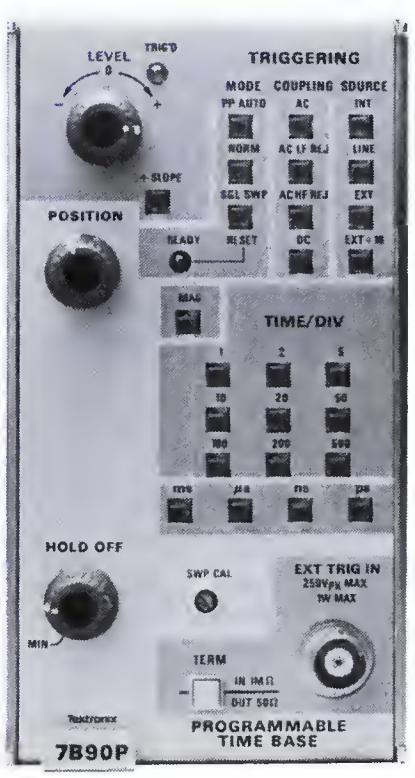
7A16P



GPIB Product

Programmable Amplifier

7B90P

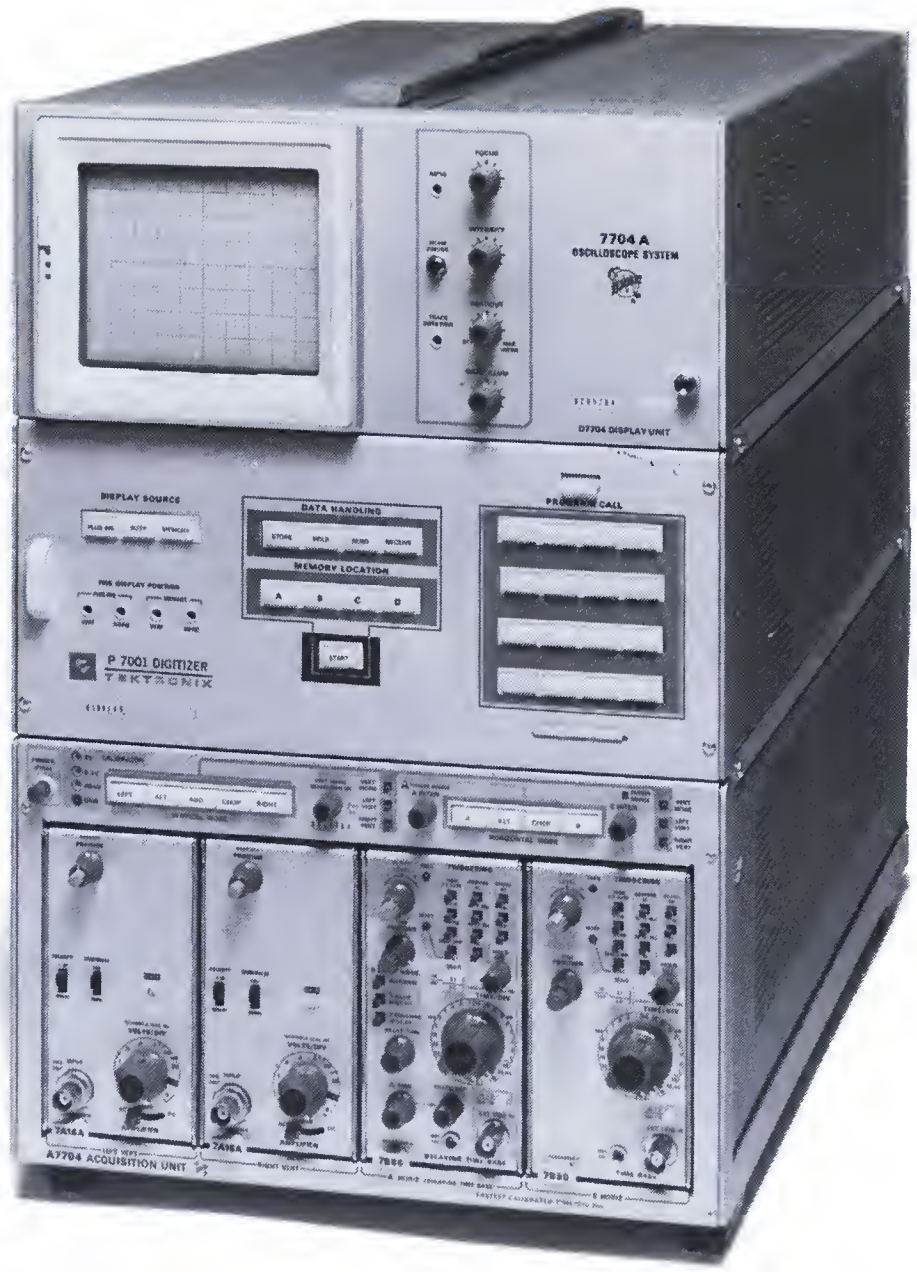


GPIB Product

Programmable Time Base

The 7A16P and 7B90P are programmable plug-ins used in the 7912AD. For further information, see plug-in specifications in the 7000 Series Plug-in Section.

175 MHz Digital Processing Oscilloscope



DPO

Dc to 175 MHz Bandwidth

Waveform Digitizing to 10 Bit Vertical and 9 Bit Horizontal Resolution

Internal Waveform Storage (4K MOS Memory)

IEEE 488 and Other Interfaces Available

GPIB Product

The DPO (Digital Processing Oscilloscope) offers both enhancement and extension of standard oscilloscope measurements. This is accomplished by adding a digitizing, storage, and interfacing unit (the P7001 Digitizer) to a TEKTRONIX 7704A General Purpose Oscilloscope System.

Standard 7000 Series plug-ins offer versatile performance from dc to 175 MHz. Additional capabilities are available via sampling plug-ins, and up to 60 GHz with spectrum analyzer plug-ins. With dual-channel plug-ins, up to four waveforms can be displayed in real time on the DPO CRT. Also, up to four waveforms with scale factor information can be stored —simultaneously or individually—in the internal MOS memory.

Waveform storage is in digital format. Amplitude samples of the waveform are taken at 512 equally spaced horizontal locations. Each amplitude sample is digitized to 10 bits (1024 distinct levels possible for each sensitivity setting) and stored in the DPO memory.

Any of the four stored waveforms can be accessed at any time by push button for re-display on the DPO CRT. Or, because they are in digital format, any or all of the stored waveforms can be transferred from the DPO to an interfaced controller. Processed waveforms can also be transferred back to the DPO for display of results.

This latter capability, the transfer of digitized waveforms to and from a computer or controller, is a DPO feature of great significance. Not only does it allow making oscilloscope measurements at computer speeds and computer resolutions, but it extends your measurement capabilities to include complete waveform analysis under program control.

Extracting information from high-speed repetitive signals is a typical application of Digital Processing Oscilloscope Systems.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments accept all 7000 Series plug-ins; function and bandwidth determined by the 7000 Series plug-ins used; 7D01 and 7D02 plug-ins are not recommended for use in the digitizing mode.

Bandwdith — 175 MHz with 7A19 plug-in amplifier.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT during real-time displays and LEFT, ALT, or RIGHT during digitizing and storage.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEMS

Channels — Two right-hand plug-in compartments compatible with all 7000 Series plug-ins; 7T11 not recommended for use in digitizing mode.

SYSTEMS

The DPO is also available in WP100 Series Signal Processing Systems. These semiautomatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, accuracy, and repeatability in characterizing devices or phenomena which give rise to repetitive waveforms in the millisecond to picosecond range. For more information on these systems, contact your local Tektronix Field Engineer.

Modes of Operation — A, ALT, CHOP, B for real-time displays. A, ALT, B for digitizing and storage with some restrictions in combinations of plug-in and mainframe vertical and horizontal switching modes.

CRT

Refer to 7704A CRT characteristics, described on page 90.

OUTPUTS/INPUTS

Refer to 7704A Outputs/Input characteristics, described on page 90.

CALIBRATOR

Refer to 7704A Calibrator characteristics, described on page 90.

DIGITIZING AND STORAGE

Method — Pseudo-random every 6.5 microseconds with a maximum of 512 samples per waveform. Any transient longer than five milliseconds or any repetitive signals that can be displayed on the CRT can be stored in internal memory along with its scale factors and redisplayed on the CRT.

Resolution — 10 bits (1024 levels).

Memory — Type: MOS. Size: 1024 10-bit words per waveform, total of 4K words. Record Length: 512 samples per waveform plus scale factors and areas for computer-generated messages.

PROGRAMMABLE FUNCTIONS

The P7001 Data Handling mode, Display Source, and Memory Locations can be selected by an external controller, and the Program Call Buttons generate interrupts which can be processed by an external controller. Also, an external controller can be used to read the status of the time-base single sweep and to arm the sweep for transient acquisition.

INTERFACING

And IEEE 488 compatible interface is available for general purpose use. Also, a 16 bit parallel interface (CP Bus Interface) is available for fast data transfer to 16 bit controllers. Complete interfacing to PDP*-11 series minicomputers available on request.

*PDP is a registered trademark of Digital Equipment Corporation.

POWER REQUIREMENTS

Range — 90 to 132 V ac. Option 09, 180 to 264 V ac.

Line Frequency — 48 to 440 Hz.

Power Consumption — 300 watts maximum at 115 V, 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions — Height, 18.9 in (47.5 cm). Width, 12 in (30.6 cm). Length, 22.7 in (57.7 cm).

Weight — 48 lbs. (21.8 kg).

STANDARD ACCESSORIES

One pin-to-BNC cable.

One each Operator and Service manuals.

ORDERING INFORMATION

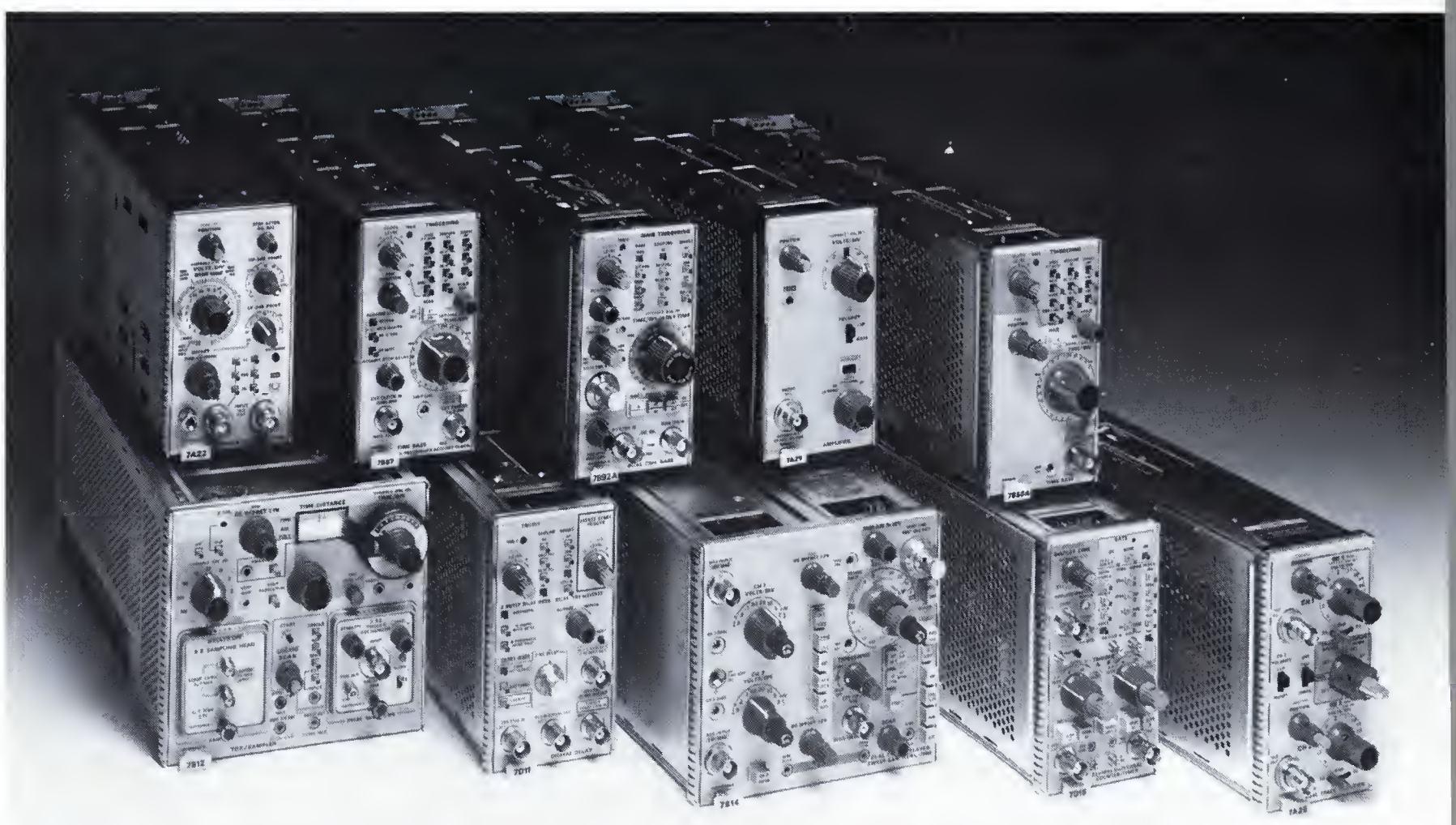
(Plug-ins not included)

DPO $11,350

DPO OPTIONS

03	Add EMC shielding	Add $185
09	Change line voltage (230 V/50 Hz)	No Charge
18	Change to 1K MOS memory	Sub $1045
19	Change to 2K MOS memory	Sub $760
20	Change to 4K core memory	Add $315
31	Add IEEE 488 Bus Interface (021-0206-00)	Add $2000
32	Add CP Bus Interface (021-0116-03); order cable separately (012-0432-00)	Add $475

7000 Series Plug-Ins



The 7000 Series . . . more than an oscilloscope

For the 7000 Series you can select from over thirty different plug-ins. For example, digital multimeters, counters and A-D converters. With this plug-in selection you can solve problems in many applications including spectrum analysis, curve tracing, spectroscopy, logic analysis, and sampling. This variety lets you tailor your instrument to meet your immediate need. And to expand its capabilities later as your needs change.

Special Purpose Plug-ins

7D01 Logic Analyzer	see page 35
7D02 Logic Analyzer	see page 31
DF1 Display Formatter	see page 36
DF2 Display Formatter	see page 36
DL2 Digital Latch	see page 37
7CT1N Curve Tracer	see page 237
7L5//L1/L2/L3 Spectrum Analyzer	see pages 247, 248
7L12 Spectrum Analyzer	see page 245
7L13 Spectrum Analyzer	see page 244
7L18 Spectrum Analyzer	see page 243
7K11 CATV Preamplifier	see page 250
7M13 Readout Unit	see page 123

7000 Series Plug-ins

Single-Trace Amplifiers
Differential Amplifiers
Dual-Trace Amplifiers
Delayed and △ Delaying Time Base
Dual Time Bases
Curve Tracer
Digital Delay
A/D Converter
Digital Multimeter
Universal Counter/Timer
Sampling

Tektronix offers maintenance training classes on 7000 Series plug-ins and mainframes and new multi-media training packages on Digital Counter and Meter Concepts and Sampling Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

7A15A

Dc to 80 MHz Amplifier

7A15A

Dc-to-80 MHz Bandwidth (7900 Family)

5 mV/div to 10 V/div Calibrated Deflection Factors

500 μV/div at 10 MHz (X10 Gain)

1 MΩ Input

The 7A15A is an easy to use, 80 MHz amplifier that features a X10 magnifier to increase the sensitivity to 500 μV/div with 10 MHz bandwidth. It has a constant bandwidth at all deflection factors in the X1 setting. Polarity of the display is selectable.

Deflection Factor — 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 gain accuracy is within 2% with X1 gain adjusted at 10 mV/div. X10 gain (increases sensitivity to 500 μV) accuracy is within 10% at 10 MHz bandwidth throughout deflection factor settings. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ within 2%; ≈ 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less.

Order 7A15A Amplifier $540

7A16A

Dc to 225 MHz Amplifier

7A16A

Dc-to-225 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div Calibrated Deflection Factors

1 MΩ Input

The 7A16A is an easy to use, 225 MHz amplifier. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable; bandwidth is selectable to FULL or limited to 20 MHz for low-frequency applications.

Deflection Factor — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

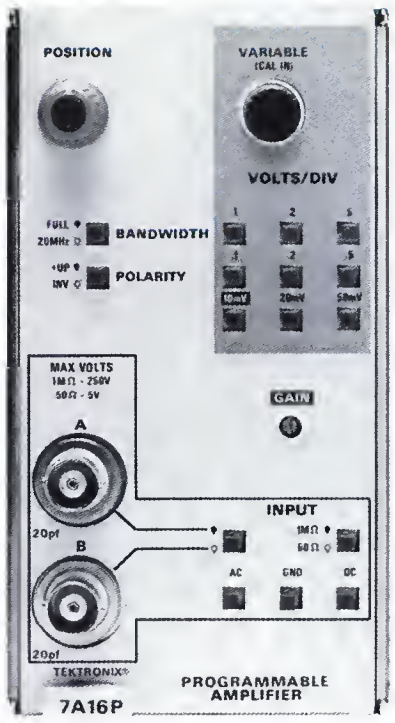
Input R and C — 1 MΩ within 2%; ≈ 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

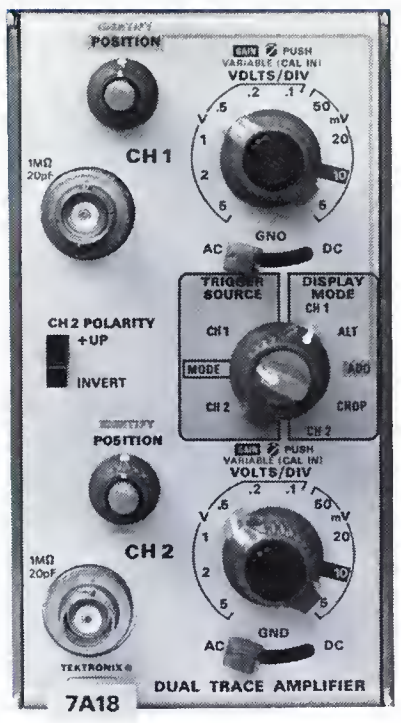
Dc Stability — Drift with ambient temperature (constant line voltage) is 0.01 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hour warm-up.

Order 7A16A Amplifier $980

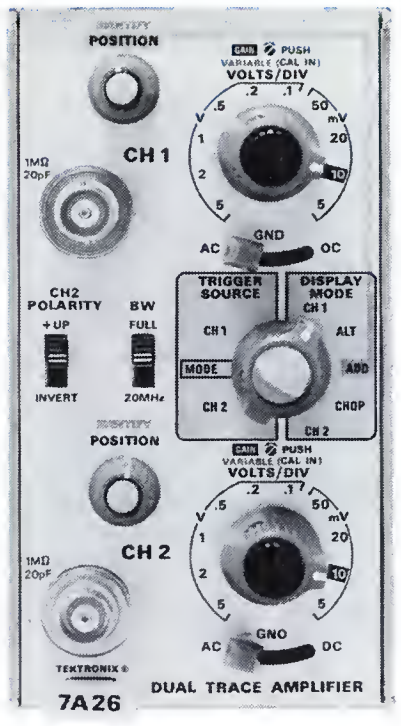
For recommended probes—refer to page 80).



7A16P



7A18



7A26

Programmable—Dc to 225 MHz Amplifier

Dc to 75 MHz Dual-trace Amplifier

Dc to 200 MHz Dual-trace Amplifier

7A16P

GPIB Product

Fully Programmable Plug-in for 7912AD or 7612D Digitizers only

10 mV/div to 5 V/div Calibrated Deflection Factors

200 MHz Bandwidth (7900 Family)

50 Ω or 1 MΩ Input Selectable

The 7A16P is designed for use only in Tektronix 7000 Series Programable Digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the IEEE 488 bus. Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the IEEE 488 bus by an external controller for input to instrument set-up and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

CHARACTERISTICS

Bandwidth — 225 MHz, plug-in only. 200 MHz In the 7912AD. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.

Ac Coupled Lower Bandwidth — 10 Hz or less.

Step Response — 50 Ω input plug-in only, 1.8 ns rise time.

Deflection Factor — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with GAIN adjusted at 10 mV/div.

Uncalibrated VARIABLE is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.

Input R and C — Selectable: 1 MΩ within 2% and ≈20 pF or 50 Ω ±1 Ω with VSWR ≤1.5:1 at 200 MHz or less.

Inputs — Selectable A or B signal input connectors.

Max Input Voltage — 1 MΩ, dc coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. 1 MΩ, ac coupled: 500 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. 50 Ω: 0.5 watts max.

Programmable Functions — All functions except VARIABLE, GAIN, and IDENTIFY are programmable.

7A16P Programmable Amplifier $1640

7A18

Dc-to-75 MHz Bandwidth

5 mV/div to 5 V/div Calibrated Deflection Factors

1 MΩ Input

The 7A18, the basic building block of 3- and 4-trace operation, is a dual-trace plug-in amplifier. The 7A18 features constant bandwidth for all deflection factors, 5 operating modes (Ch 1, Ch 2, ALT, CHOP, ADD), trigger source selectivity and color-keyed control grouping. The 7A18 has a trace identify function. Polarity of channel 2 is selectable.

Deflection Factor — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 10 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈ 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

Dc Stability — Drift with ambient temperature (constant line voltage) is 0.01 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hour warm-up.

Common-Mode Rejection Ratio (ADD, Ch 2 Invert) — At least 10:1, dc to 50 MHz.

Order 7A18 Amplifier $1080

Dc Offset Option

Dc Offset is for the user who needs to analyze small signals that are riding on larger signals, such as power supply ripple.

Option 06, Dc Offset — Two separate Channel 1 and Channel 2 variable offset controls are concentric with the position controls replacing the identify pushbuttons of the standard 7A18. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

Offset Range Display — ±200 div max, equivalent to ±1 V at 5 mV/div.

Accuracy — When in DC OFFSET the deflection accuracy is derated by 1%.

Order Option 06 Dc Offset . . . . . Add $200

7A26

Dc-to-200 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div Calibrated Deflection Factors

1 MΩ Input

The 7A26, a dual-trace plug-in amplifier, is a basic building block for 3- or 4-trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (Ch 1, Ch 2, ALT, CHOP, ADD), trigger source selection (Ch 1, Ch 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable. Bandwidth may be set at FULL or limited to 20 MHz for low-frequency applications.

Deflection Factor — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

Input R and C — 1 MΩ within 2%; ≈ 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

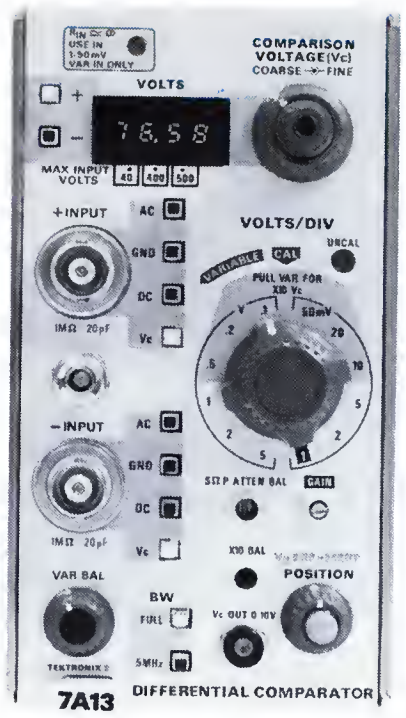
Common-Mode Rejection Ratio (ADD, Ch 2 Invert) — At least 10:1, dc to 50 MHz.

Dc Stability — Drift with ambient temperature (constant line voltage) is 0.02 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hour warm-up.

Order 7A26 Amplifier $1745

For recommended probes—refer to page 80).

Differential Amplifiers



7A13

Differential Amplifier Comparator

Dc-to-105 MHz Bandwidth (7900 Family)

1 mV/div to 5 V/div Calibrated Deflection Factors

20,000:1 CMRR

10,000 Cm Effective Screen Height

1 MΩ Input

The 7A13 is a differential comparator amplifier. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to FULL or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and −) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 loses its differential capability, but provides an accurate (0.1%) positive or negative internal offsetting voltage covering the common-mode signal range of the unit. A signal of up to ±10 V may be applied to an input (+ or −) at a deflection factor setting of 1 mV/div and, with an opposing Vc (offset voltage), viewed in 10,000 segments of 1 mV. The offset voltage is also available as an output for external monitoring.

Input R and C — 1 MΩ within 0.15%; ≈ 20 pF. R in ≈ ∞, is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

Deflection Factor — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

Signal Range

Deflection Factor Settings	1mV to 50mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
Common-mode Signal Range	±10 V	±100 V	±500 V
Max Dc-coupled Input (dc + Peak Ac at 1 kHz or less)	±40 V	±400 V	±500 V
Max Ac-coupled Input (dc voltage)		±500 V	

Max Input Gate Current — 0.2 nA or less from 0°C to +35°C; 2 nA or less at +85°C to +50°C.

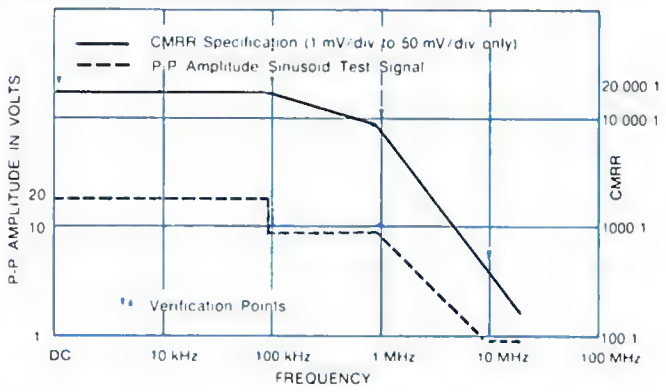
Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minute warm-up. Long term, 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hour interval after 20 minute warm-up. Drift with ambient temperature (constant line voltage), 2 mV/10°C to 0.2 div/10°C or less, whichever is greater.

Displayed Noise (Tangentially measured) — With X10 Vc in, 400 μV (200 μV rms) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc out, 0.4 div or less at 10 mV/div to 0.5 V/div.

Overdrive Recovery — 1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only regardless of pulse duration.

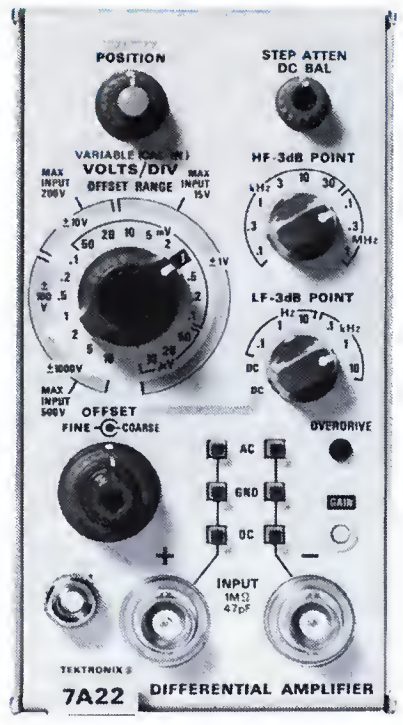
Internal Comparison Voltage — Range, 0 V to ±10 V; accuracy, ±(0.1% of setting + 3 mV); Vc output R, approx 15 kΩ.

Common-Mode Rejection Ratio



At least 2000:1, 10 mV/div to 50 mV X10 Vc out) and 0.1 V/div to 5 V/div. Ac-coupled input at least 500:1 at 60 Hz.

Order 7A13 Amplifier $2540



7A22

Differential Amplifier

Dc-to-1 MHz Bandwidth

10 μV/div to 10 V/div Calibrated Deflection Factors

100,000:1 CMRR

Selectable Upper and Lower −3 dB Points

Dc Offset

10 μV/Hour Dc Drift*

1 MΩ Input

The 7A22 is a differential amplifier well suited for difficult low-amplitude, low-frequency measurements.

*With constant temperature. See dc stability specifications.

Bandwidth — Hf −3 dB point; selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; rise time in 1 MHz position is 350 ns ±9%. Lf −3 dB point; selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency. The switch also contains dc and dc with OFFSET positions. Ac-coupled at input, 2 Hz or less.

Deflection Factor — 10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 1 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ within 1%; ≈ 47 pF.

Max Input Gate Current — Differentially measured, 40 pA (+25°C) and 200 pA (+50°C) at 10 μV/div to 10 mV/div; 10 pA (+25°C) and 20 pA (+50°C) at 20 mV/div to 10 V/div. Single ended, one-half the differential measurement. Display shift is ±4 div (+25°C) and ±20 div (+50°C) at 10 μV/div (ac-coupled).

For recommended probes—refer to page 80).

Signal and Offset Range

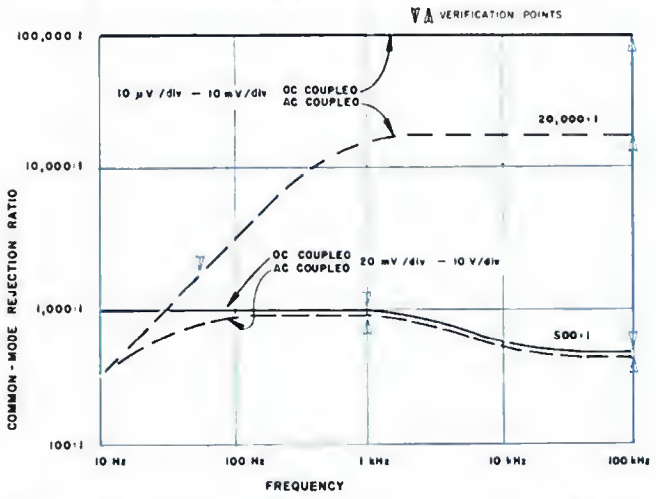
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-mode Signal Range	±10 V	±100 V	±500 V	
Max Dc-coupled Input (dc + peak ac at 1 kHz or less)	±15 V	±200 V	±500 V	
Max Ac-coupled Input (dc voltage)	±500 V dc rejection, at least 4 x 10^5:1			
Dc Offset Range	+1 V to −1 V	+10 V to −10 V	+100 V to −100 V	+1000 V to −1000 V

Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 5 μV (p-p) or 0.1 div, whichever is greater in any minute after 1 hour warm-up. Long term, 10 μV (p-p) or 0.1 div, whichever is greater in any hour after 1 hour warm-up. Drift with ambient temperature (constant line voltage) is 50 μV/°C or less.

Displayed Noise — 16 μV or 0.1 div (whichever is greater) at max bandwidth; source resistance 25 Ω or less measured tangentially.

Overdrive Recovery — 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front-panel OVERDRIVE light indicates that an overdrive condition is being approached.

Common-mode Rejection Ratio (for signals not exceeding common-mode signal range)



Order 7A22 Amplifier **$1325**

7A11

Amplifier

7A11

Built-in FET Probe

Dc-to-250 MHz Bandwidth (7900 Family)

5 mV/div to 20 V/div

Calibrated Deflection Factors

Dc Offset

1 MΩ Input

The 7A11 is a wideband plug-in amplifier. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 MΩ) and low capacitance (5.8 pF at 5 mV/div), without loss of signal amplitude by probe attenuation. Two 20X attenuators, physically mounted in the probe tip, are relay-switched into the input signal path at the appropriate deflection factor. Therefore you need not concern yourself with manual plug-on attenuators and signal dynamic range.

Deflection Factor — 5 mV/div to 20 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2% of gain adjustment at 0.1 V/div. Uncalibrated VARIABLE is continuous between steps to at least 50 V/div.

Input R and C — 1 MΩ within 1%; ≈ 5.8 pF (5 mV/dlv to 50 mV/div), ≈ 3.4 pF (0.1 V/div to 1 V/div), ≈ 2 pF (2 V/div to 20 V/div).

Signal and Offset Range

Deflection Factor Settings	5 mV/div to 50 mV/div	0.1 V/div to 1 V/div	2 V/div to 20 V/div
Offset Range	+1 V to −1 V	+20 V to −20 V	+400 V to −400 V
Offset Range to Offset Out	1:1 within 1% +0.5 mV	20:1 within 1.5% +0.5 mV	400:1 within 2% +0.5 mV
Max Dc-coupled Input	200 V (dc + peak ac, ac component to 50 kHz)	200 V (dc + peak ac, ac component to 40 MHz)	200 V (dc + peak ac, ac component to 70 MHz)
Max Ac-coupled Input (Dc Component)	±200 V		

Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 0.1 div or less per minute after 20 minute warm-up. Long term, 0.3 div or less per hour after 20 minute warm-up. Drift with ambient temperature (constant line voltage), 200 μV/°C or less.

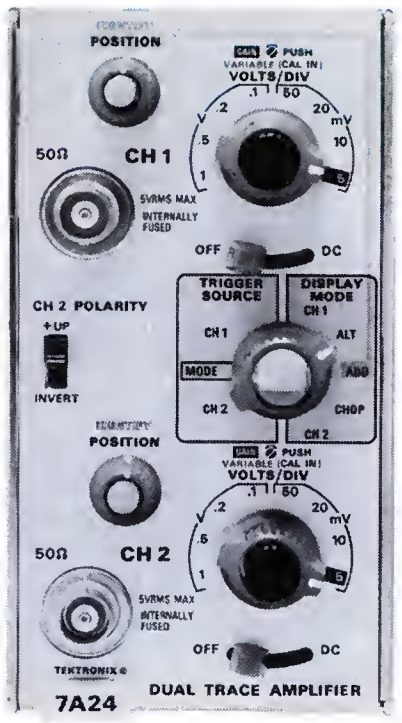
Displayed Noise—0.5 mV or 0.1 div, whichever is greater, in FULL BANDWIDTH mode, measured tangentially.

Offset Function — An internal dc source, continuously variable between +1 V and −1 V, may be used to offset the trace. (See chart for offset range.) An OFFSET OUT jack allows for monitoring of the offset voltage. OFFSET OUT source resistance is 500 Ω within 3%.

Included Accessories — Capacitor-coupler head (011-0110-00); retractable hook tip (013-0106-00); probe tip ground adapter (013-0085-00); 3 in ground lead (nose) (175-0849-00); 3 in ground lead (screw-in) (175-0848-00); 12 in ground lead (screw-in) (175-0848-02); three miniature alligator clips (344-0046-00); two insulated sleeves (166-0404-01); probe hook tip (206-0114-00); probe tip to GR 50 Ω termination (017-0088-00); 18 in cable (offset out) (175-1092-00).

Order 7A11 Amplifier **$2195**

Amplifiers



7A24

DC to 400 MHz Dual-trace Amplifier

7A24

Dc-to-400 MHz Bandwidth (with 7104)

5 mV/div to 1 V/div Calibrated Deflection Factors

50 Ω Input

The 7A24, a high-performance, wide band, dual-trace amplifier, is designed primarily for use with the 7700, 7800, 7900, and 7100 Series Mainframes. The 7A24 offers 350 MHz bandwidth and 5 mV/div sensitivity; this provides the basic building block for 3 or 4 trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable.

Deflection Factor — 5 mV/div to 1 V/div in 8 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 5 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 2.5 V/div.

Input R — 50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

Max Input — 5 V rms; 0.5 W max input power, internally protected.

Common-Mode Rejection Ratio — At least 10:1, dc to 50 MHz.

Dc Stability — Drift with ambient temperature (constant line voltage) is 0.02 div/°C. Drift with time (ambient temperature and line voltage constant), 0.02 div in any one minute after 1 hour warm-up.

Order 7A24 Amplifier **$1970**

7A19

DC to 600 MHz Amplifier

7A19

Dc-to-600 MHz Bandwidth (with 7104)

10 mV/div to 1 V/div Calibrated Deflection Factors

Optional ±500 ps Variable Delay Line

50 Ω Input

The 7A19 is a high-performance, wide band, single-trace plug-in amplifier designed primarily for use with the 7100, 7700, 7800, and 7900 Family Mainframes. The polarity of the display is selectable, either normal or inverted.

Deflection Factor — 10 mV/div to 1 V/div in 7 calibrated steps (1-2-5 sequence). Accuracy is within 3%.

Input R — 50 Ω.

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

Max Input — 50 div peak or 10 V rms (2 W), whichever is less, in the dc-coupled mode. 100 V dc additional in the ac-coupled mode.

Order 7A19 Amplifier **$1800**

7A19 OPTION

Order Option 04 Variable Sig Delay . . . . . **Add $350**

7A29

DC to 1 GHz Amplifier

7A29

Dc-to-1 GHz Bandwidth (7104)

10 mV/div to 1 V/div Calibrated Deflection Factors

50 Ω Input

The 7A29 is a high performance, wide-bandwidth, single-trace plug-in amplifier designed primarily for use with the 7104 Mainframes. A vertical amplifier to bw of mainframe, the 7A29 has a 10 mV/div to 1 V/div vertical sensitivity.

Deflection Factor — 10 mV/div to 1 V/div in 7 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated variable is continuous between steps to at least 2.5 V/div.

Input R — 50 Ω.

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is 1 ns.

Max Input — 10 V rms or 1 W-second pulses not exceeding 50 V peak in dc coupled mode. 100 V dc additional in ac coupled mode.

Input Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

Order 7A29 Amplifier **$2320**

7A29 OPTION

Order Option 04 Variable Sig Delay . . . . . **Add $350**

For recommended probes—refer to page 80).

Programmable and Digital Pretrigger Time Base

7B90P

500 ps/div to 500 ms/div Calibrated Time Base

Fully Programmable Plug-in 7912 AD Digitizer only

400 MHz Trigger Bandwidth

Single-Sweep Operation

GPIB Product

The programmable 7B90P is designed for use with a TEKTRONIX 7912AD Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the IEEE 488 bus. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

CHARACTERISTICS

Sweep Rates — 500 ms/div to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.

Sweep Accuracy — Measured over center 8 div, +15°C to +35°C, with any 7000 Series programmable mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div	Unmagnified	Magnified
500 ms/div to 100 ns/div	2%	3%
50 ns/div to 10 ns/div	3%	4%
500 ps/div	—	5%

Trigger Holdoff — Programmable in 62 steps between minimum and maximum.

Time/Div	Min (ccw)	Max (cw)
500 ps/div to 2 μs/div	≤3.5 μs	≥90 μs
5 μs/div to 20 μs/div	≤35 μs	≥900 μs
50 μs/div to 200 μs/div	≤350 μs	≥9 ms
500 μs/div to 2 ms/div	≤3.5 ms	≥90 ms
5 ms/div to 500 ms/div	≤35 ms	≥900 ms

Triggering Sensitivity —

P-P AUTO MODE

Triggering Frequency Range	Min Signal Required	
	INT	EXT
At least 50 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

NORM Mode

Coupling	Triggering Frequency Range	Min Signal Required	
		INT	EXT*
AC	30 Hz to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV
AC LF REJ[1]	30 kHz to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV
AC HF REJ[2]	30 Hz to 50 kHz	0.3 div	100 mV
DC	Dc to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV

*EXT ÷10 operation attenuates external trigger signal 10 times.

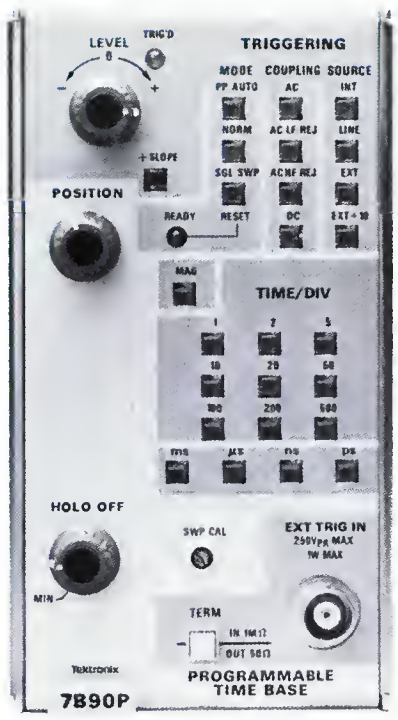
[1]Will not trigger on sine waves of less than 8 div, INT, or 3 V, EXT, at or below 60 Hz.

[2]Will not trigger on 50 MHz sine waves 1.5 div or less, INT, or 0.15 V or less, EXT.

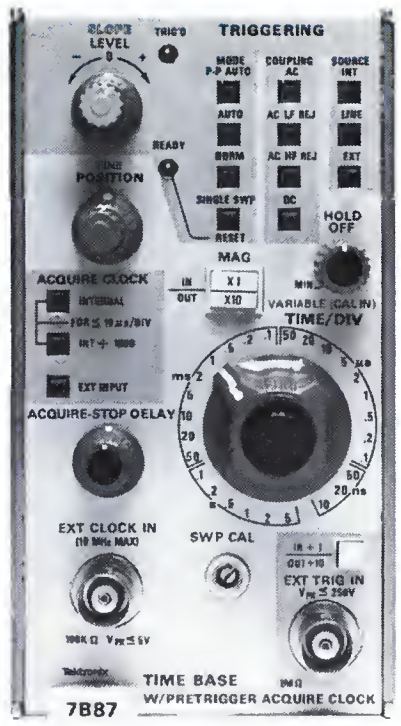
Single-Sweep Mode — Same as NORM mode.

Trigger Level — Programmable in 0.05 div steps.

Horizontal Position — Programmable in 0.0125 div step unmagnified, 0.125 div step magnified.



7B90P



7B87

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

External Trigger Input — Selectable: 1 MΩ ±5%, 20 pF ±10% or 50 Ω ±5% with 1.22 max VSWR at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or 1 watt for 50 Ω. The level range (excluding p-p AUTO) for a 1 kHz sine wave input is at least ±3 V in EXT and at least ±30 V in EXT ÷10.

Order 7B90P Programmable Time Base $1915

NEW 7B87

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Pretrigger when used with 7854

The 7B87 is a time base designed for use with the 7854 mainframe to provide additional pre-trigger capability. It may be used with the 7700, 7800 and 7900 series mainframe as a delaying time base. The pre-trigger feature is only compatible with the 7854 at this time. When used in the A horizontal, the 7B87 is a delaying time base. When used in the B horizontal of the 7854, the 7B87 provides both single shot and pre-trigger capability to the 7854.

The 7B87 has the same characteristics as the 7B80/7B85 time base plug-ins except for single shot pre-trigger capability. Pre-trigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pre-trigger time is determined by the Acquire-Stop delay time setting. The total amount of pre-trigger is 0.2 to 9.9 times the time/div setting.

The INT ÷1000 control reduces the stored time/div to 1000 times slower than the real time display on a 7854. This does not, however, affect the Acquire-Stop delay time. The INT ÷1000 control allows stored sweep speeds from 10 ms to 5000 sec/div for slow speed applications.

An EXT CLOCK-IN connector is provided for clock frequencies other than what is offered by the INT clock of the 7B87.

CHARACTERISTICS

Sweep Rates — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). 10X MAGNIFIER extends fastest calibrated sweep rate to 1 ns div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy — Measured over the center 8 div, +15°C to +35°C, in the 7700, 7800, or 7900 Series Mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div[1]	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

[1]Fastest calibrated sweep rate is limited by 7700 and 7600.

Trigger Holdoff Time —

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
	0.5 μs/div to 10 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster	

Delay Time Range — 0.2 or less to at least 9.0 times TIME/DIV setting.

Jitter — 0.02% of TIME/DIV setting + 0.1 ns, or less.

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes) — from repetitive signals)

Coupling	Triggering Frequency Range[1]	Min Signal Required	
		Int	Ext
AC	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
AC LF REJ[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
DC[3]	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV

[1]Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.

[2]Will not trigger on sinewaves of less than 8 div Int, or 3 V Ext, at or below 60 Hz.

[3]Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto trigger mode.

Single Sweep — Requirements are same as for repetitive inputs.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

Sensitivity (P-P AUTO Mode) — (ac or dc coupling)

Triggering Frequency Range	Min Signal Required	
	Int	Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV
Low Frequency Response: At least 50 Hz	2.0	500 mV

External Trigger Input — Max input voltage is 250 V (dc + peak ac). Input R and C is 1 MΩ within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ±1.5 V in EXT ÷1, and at least ±15 V in EXT ÷10.

Internal Clock — Pre-trigger 0.02048 Hz to 20.45 MHz determined by the time/div, X10 mag, and ÷1000 switches. Accuracy of Internal + INT ÷1000 = 0.1%.

External Clock — Max input is 5 V pk. Input R is 100 KΩ within 5%. Threshold voltage TTL compatible. Max input freq. 10 MHz with BNC Input. Delay 0.5 μs or less.

Acquire Stop Delay — Total range is 0.2 or less to at least 9.9 times Time/Div setting. Jitter from 5 s/div to 10 μs/div 0.07% of time/div setting or less. Delay accuracy (+15°C to +35°C) from 0.5 s/div to 10 μs/div is within 0.5% of measurement plus 5% of time/div setting.

Single Shot Performance — Using 7B87 with 7854 Internal Clock.

Fastest Sweep (Time/Div)	Points per waveform
50μs	128
100μs	256
200μs	512
500μs	1024

Order 7B87 Time Base $1400

Delayed & △ Delaying Time Base

7B10 and 7B15

7B15 Features:

- △ Time Measurements with CRT Readout
- Delay Time Measurements with CRT Readout
- Vertical Trace Separation between Two Delayed Sweeps

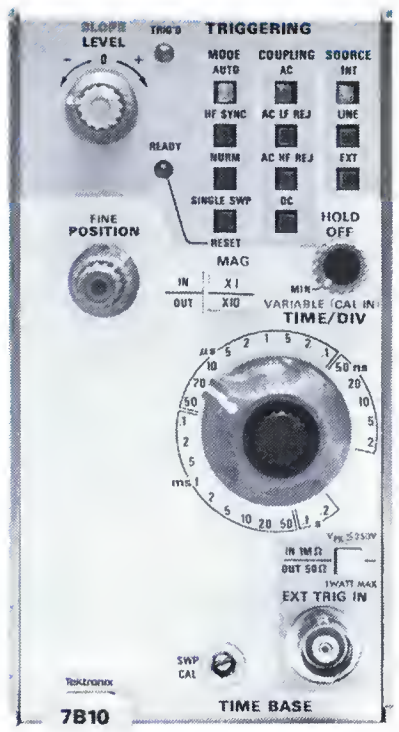
Both Feature:

- 0.2 ns/div to 0.5/div Calibrated Time Bases
- Triggering to 1 GHz
- Variable Trigger Holdoff
- Peak-to-Peak Auto Triggering

The 7B10 and 7B15 are horizontal time bases designed for use with the 7104 Mainframe to provide optimum bandwidth/sweep-speed/compatibility, but may also be used with the 7700, 7800, and 7900 Series Mainframes. (Each may be used in any slower 7000 Series Mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

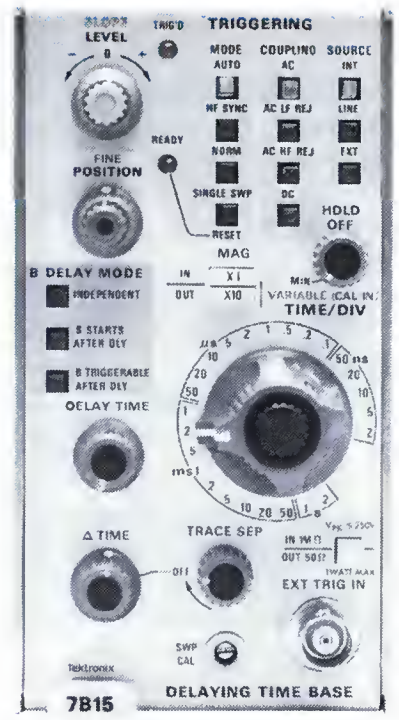
The 7B10 and 7B15 or the 7B80 and 7B85 provide the △ time measurement capability in addition to the standard delay time capability. Either time interval is digitally displayed on the CRT. A single intensified zone which you can position anywhere on the trace identifies the delay time interval (the time from the "A" or main sweep to the start of the intensified zone). Two intensified zones which you can position anywhere on a trace identify the △ time interval (time between intensified zones). Alternate sweep switching makes it possible to display the information between the intensified zones full screen at the "B" sweep speed. By overlapping the two expanded waveforms, you are confident of the exact positioning of the intensified zones on the "A" sweep. This results in easy-to-make, precise and repeatable timing measurements.

By rotating the TRACE SEPARATION control out of the OFF position, the △ time mode is activated. Two intensified zones can be independently positioned. As in the conventional delay mode, the DELAY TIME knob adjusts the time to the first intensified zone; the △ TIME knob adjusts the time between the two intensified zones. Now, the CRT digital readout shows the △ time between the two delays.



7B10

Delayed Time Base



7B15

△ Delaying Time Base

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

CHARACTERISTICS

Sweep Rates — 0.2 s/div to 2 ns/div in 25 steps. X10 MAGNIFIER extends fastest calibrated sweep rate to 0.2 ns/div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep.

Sweep Accuracy — Measured over the center 8 div, +15°C to +35°C, in the 7104, 7900, or 7800 Series Mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div[1]	Unmagnified	Magnified
0.2 s/div to 10 ns/div	2%	3%
5 ns/div and 2 ns/div	3%	4%

[1]Fastest calibrated sweep rate is limited by 7900, 7800, 7700, and 7600.

Trigger Holdoff Time —

	Minimum	Maximum with VARIABLE
0.2 s/div to 50 ms/div	40 ms	400 ms
20 ms/div to 2 μs/div	X2 the TIME/Div Setting	X20 the TIME/Div Setting
1 μs/div to 0.5 μs/div	2 μs	20 μs
0.2 μs/div to 2 ns/div	2 μs	6 μs

△ Time Range — 0 to at least 9 times TIME/DIV setting.

△ Time Accuracy — Within (0.5% measurement plus 3 least significant digits) 20 ms/div to 100 ns/div.

Trace Separation Range — Functional only in △ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times TIME/DIV setting.

Jitter — 0.02% of TIME/DIV setting up through 50 μs/div. 0.03% of TIME/DIV setting plus 0.1 ns for sweep speeds of 20 μs/div through 100 ns/div.

TRIGGERING

Triggering Sensitivity

Coupling	Triggering Frequency Range[2]	Minimum Triggering Signal Required	
		Internal	External
Ac	30 Hz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
Ac Lf REJ[2]	50 kHz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
Ac Hf REJ	30 Hz to 40 kHz	0.5 div	50 mV
Dc[3]	Dc to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV

[1]The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.

[2]Will not trigger on sine waves at or below 60 Hz when amplitudes are less than 8 division Internal or 3 volts External.

[3]The Triggering Frequency Range for DC COUPLING applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

Single Sweep — Requirements are the same as for repetitive inputs.

Internal Trigger Jitter — 30 ps or less at 1 GHz into 0.3 div, (50 mV EXTERNAL).

Hf Sync Mode — 250 MHz to 1 GHz.

External Trigger Input — Max input voltage is 250 V (dc + peak ac) for 1 MΩ input 1 W average for 50 Ω input. Input R and C for 1 MΩ Input is 1 MΩ within 5%, 20 pf within 10%; for 50 Ω input, 50 Ω within 2%. Level range is at least ±3.5 V in EXT ÷1.

ORDERING INFORMATION

Order 7B10 Time Base $1830

Order 7B15 Delaying Time Base $2075

Delayed & △ Delaying Time Base

7B80 and 7B85

7B85 Features:

- △ Time Measurements with CRT Readout
- Delayed Time Measurements with CRT Readout
- Vertical Trace Separation between Two Delayed Sweeps

Both Feature:

- 1 ns/div to 5 s/div Calibrated Time Bases
- Triggering to 400 MHz
- Variable Trigger Holdoff
- Peak-to-Peak Auto Triggering

The 7B80 and 7B85 are horizontal time bases recommended for use with 7700, 7800 and 7900 Series Mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000 Series Mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

Sweep Rates — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 MAGNIFIER extends fastest calibrated sweep rate to 1 ns div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep rate.

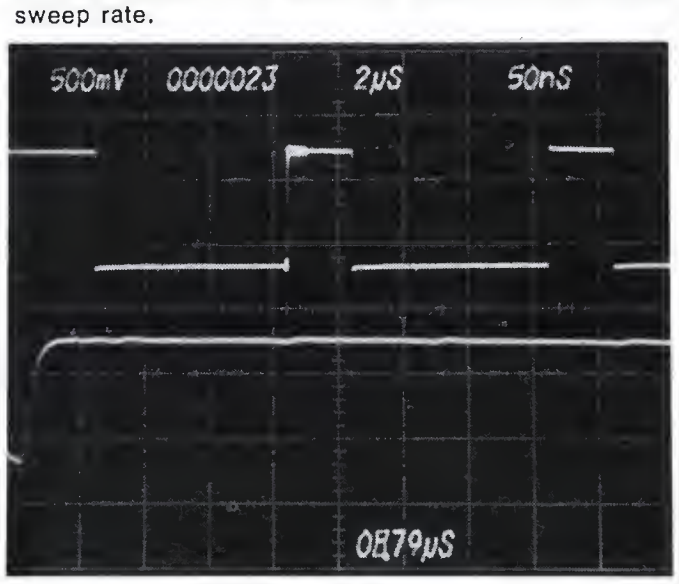


Fig 1. Delaying and delayed sweeps are shown with the mainframe selecting ALT sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.

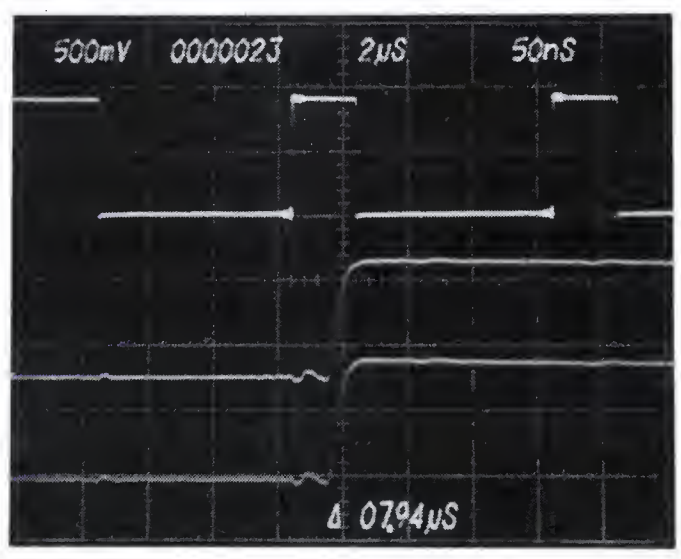
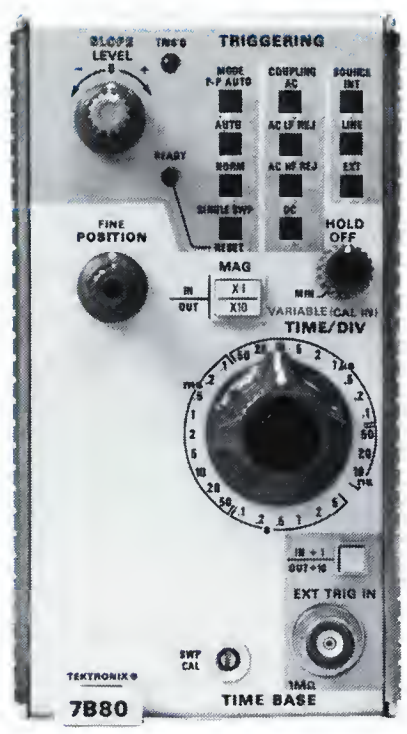


Fig 2. With the mainframe still selecting ALT sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The TRACE SEPARATION knob is used to position the second delayed sweep below the first delayed sweep with up to 3 div of separation.



7B80

Delayed Time Base

Sweep Accuracy — Measured over the center 8 div, +15°C to +35°C, in the 7700, 7800, or 7900 Series Mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div[1]	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

[1]Fastest calibrated sweep rate is limited by 7700 and 7600.

Trigger Holdoff Time —

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
	0.5 μs/div to 10 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster	

Δ Time Range — 0 to at least 9 times TIME/DIV setting.

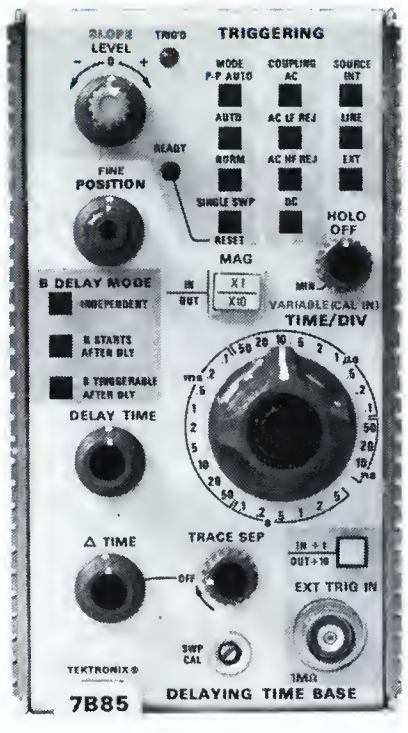
Δ Time Accuracy — (+15°C to +35°C)

Within (0.5% measurement + 0.3% of TIME/DIV setting + 1 least significant digit) from 20 ms/div to 100 ns/div.

Trace Separation Range — Functional only in △ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times TIME/DIV setting.

Jitter — 0.02% of TIME/DIV setting + 0.1 ns, or less.



7B85

△ Delaying Time Base

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes) — (from repetitive signals)

Coupling	Triggering Frequency Range[1]	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac Lf REJ[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac Hf REJ	30 Hz to 50 kHz	0.3 div	50 mV
Dc[3]	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV

[1]Triggering frequency ranges are limited to the frequency of the vertical system when operatng in the Internal mode.

[2]Will not trigger on sine waves of less than 8 div Int, or 3 V Ext, at or below 60 Hz.

[3]Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto triggering mode.

Single Sweep — Requirements are same as for repetitive inputs.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

Sensitivity (P-P AUTO Mode) — (ac or dc coupling)

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV
Low Frequency Response: At least 50 Hz	2.0 div	500 mV

External Trigger Input — Max input voltage is 250 V (dc + peak ac). Input R and C is 1 MΩ within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ±1.5 V in EXT ÷1, and at least ±15 V in EXT ÷10.

7B80 Option 02

X-Y Phase Shift (Determined by the circuitry in mainframe) — For mainframe without X-Y horizontal compensation, the mainframe phase shift specifications are retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

ORDERING INFORMATION

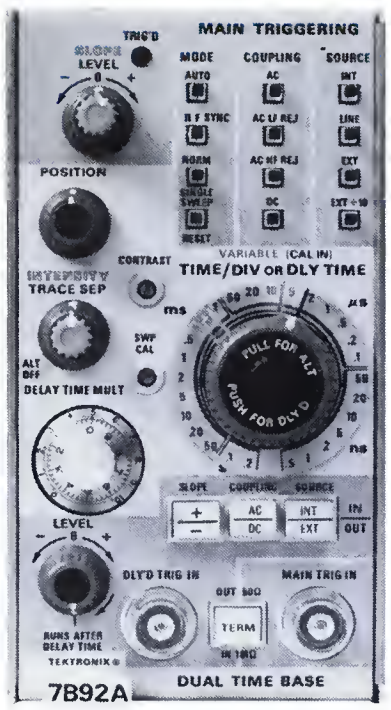
Order 7B80 Time Base $1190

Order 7B85 Delaying Time Base $1425

7B80 OPTION

Order Option 02, X-Y ..... Add $100

Dual Time Base



Dual Time Base

7B92A

0.5 ns/div to 0.2 s/div Calibrated Time Base

Triggering to 500 MHz

Alternate Display of Intensified Delaying and Delayed Sweeps

Contrast Regulation between Delaying and Delayed Sweeps

The 7B92A Dual Time Base is recommended for use only in the 7800 and 7900 Series Mainframes (the 7B92A may be used in all other mainframes at slower sweep speeds).

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep (excepting alternate in R7704). When operating in the AUTO mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

DELAYING SWEEP (MAIN SWEEP)

Sweep Rate — 0.2 s/div to 10 ns/div in 23 calibrated steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900 Family Oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%

Delay Time Multiplier Range — 0 to 9.8 times the DLY TIME/DIV setting from 0.2 s/div to 10 ns/div (0 to 1.96 seconds).

Differential Delay Time Measurement Accuracy — (+15°C to +35°C).

Sweep Speed

0.2 s/div to 0.1 μs/div	Both delay time mult dial settings at 0.5 or greater	±(0.75% of measurement +0.25% of full scale)
	One or both delay time mult dial settings at less than 0.5	±(0.75% of measurement +0.5% of full scale +5 ns)
50 ns/div to 10 ns/div	Both delay times equal to or greater than 25 ns	±(1% of measurement +0.5% of full scale)
	One or both delay times less than 25 ns	±(1% of measurement +1% of full scale +5 ns)

Full scale is 10 times the TIME/DIV or DLY TIME setting. Accuracy applies over the center 8 Delay Time Multiplier div from +15°C to +35°C.

Delay Time Jitter — Not applicable for the first 2% of max available delay time (DELAY TIME MULT dial setting greater than 0.2).

0.2 s/div to 50 μs/div	1 part in 50,000 of the max available delay time
20 μs/div to 10 ns/div	1 part in 50,000 of the max available delay time +0.5 ns

Max available delay time is 10 times the TIME/DIV or DLY TIME switch setting.

MAIN TRIGGERING

Auto, Norm

Coupling	Triggering Frequency Range	Min Signal Required	
		int	Ext
Ac	30 Hz-20 MHz	0.5 div	100 mV
	20 MHz-500 MHz	1.0 div	500 mV
Ac Lf REJ*	30 kHz-20 MHz	0.5 div	100 mV
	20 MHz-500 MHz	1.0 div	500 mV
Ac Hf REJ	30 Hz-50 kHz	0.5 div	100 mV
Dc	Dc-20 MHz	0.5 div	100 mV
	20 MHz-500 MHz	1.0 div	500 mV

EXT ÷10 switch attenuates external signal 10 times.

Hf Sync — Triggering sensitivity is 0.5 div INT or 100 mV EXT, from 100 MHz to 500 MHz for any coupling except Ac Hf Rej.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Range of trigger level is at least ±3.5 V in EXT, and at least ±35 V in EXT ÷10.

DELAYED SWEEP

Sweep Rate — 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900 Family Oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div to 5 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

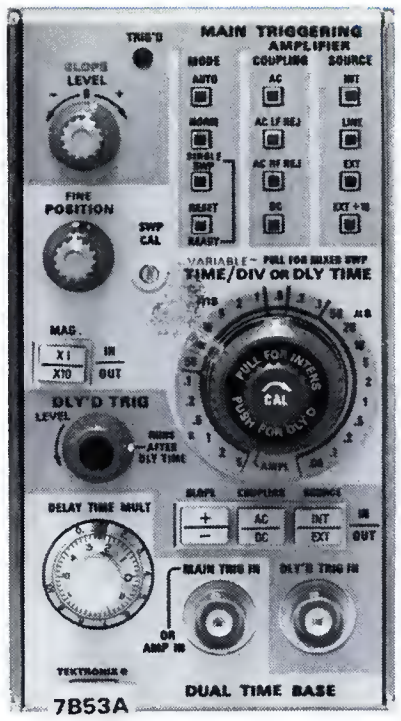
Delayed Triggering

Coupling	Triggering Frequency Range	Min Signal Required	
		int	Ext
Ac	30 Hz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Dc	DC to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1 MΩ input, and W average for 50 Ω input. Range of trigger level is at least ± 3.5 V in EXT.

Order 7B92A Dual Time Base $2815



7B53A

Dual Time Base

7B53A

5 ns/div to 5 s/div Calibrated Time Base

Calibrated Mixed Sweep

Triggering to 100 MHz

Single-Sweep Operation

Optional TV Sync-Separator Triggering

The easy-to-use 7B53A Dual Time Base is recommended for use with 7600 Mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000 Series Mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

The 7B53A Time Base features four kinds of sweep: normal, intensified delaying, delayed, and mixed. The pushbutton switches cannot be lit.

DELAYING SWEEP

Sweep Rate — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

Sweep Accuracy — Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 1 s/div	3%	4%	*	*
0.5 s/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

*Unspecified

Delay Time Multiplier Range — 0 to 10 times the DELAY TIME/DIV setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy — 5 s/div to 1 s/div ±1.4% of measurement +0.3% of full scale; 0.5 s/div to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 DTM divisions from +15°C to +35°C.

Jitter — 0.05% or less of TIME/DIV setting.

Triggering —

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 mV
Ac Lf REJ*	30 kHz-10 MHz 150 kHz-10 MHz 10 MHz-100 MHz	0.3 div —— 1.5 div	—— 100 mV 500 mV
Ac Hf REJ	30 Hz-50 kHz	0.3 div	100 mV
Dc	Dc-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 mV

*Will not trigger on sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Max input voltage is 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to −1.5 V in EXT, at least +15 V to −15 V in EXT ÷10.

DELAYED SWEEP

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps to at least 1.25 s/div and is switchable between the main, delayed sweep, and variable main sweep holdoff.

Sweep Accuracy — Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to 50°C	+15°C to +35°C	0°C to 50°C
0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	4%	5%	4.5%	6%
50 ms/div to 0.5 μs/div	3%	4%	3.5%	5%

Delayed Sweep Gate — Output voltage is approx +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise time is 50 ns or less; output R is 350 Ω within 10%. Gate is available at the DLY'D TRIG IN connector when the delayed sweep source switch is set to INT.

Triggering —

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 mV
Dc	Dc-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 mV

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Max input voltage is 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to −1.5 V in EXT.

MIXED SWEEP

Sweep Accuracy — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: first 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

EXT HORIZONTAL INPUT

Deflection Factor — 10 mV/div within 10% when in EXT, MAG X10 100 mV/div within 10% when in EXT; 1 V/div within 10% when in EXT ÷10.

Bandwidth

Coupling	Lower −3 dB	Upper −3 dB
Ac	40 Hz	2 MHz
Ac Lf REJ	16 kHz	2 MHz
Ac Hf REJ	40 Hz	100 kHz
Dc	Dc	2 MHz

TV SYNC

Option 05, TV Sync Separator Triggering — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed circuit tv systems, domestic or overseas, with up to 1201-line, 60 Hz field rates. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system.

ORDERING INFORMATION

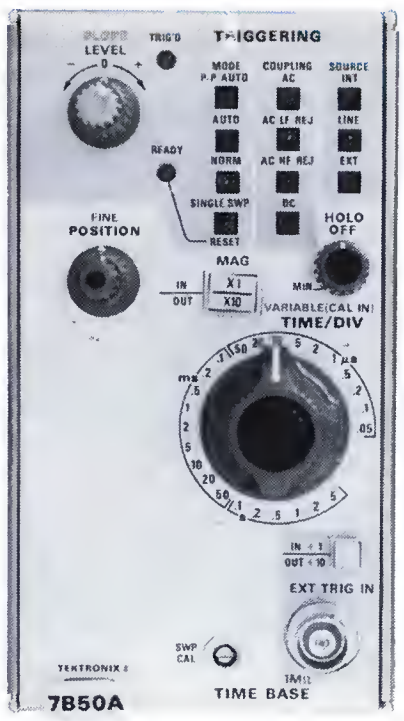
Order 7B53A Dual Time Base $1295

7B53A OPTION

Order Option 05, TV Triggering . . . . . Add $150

Option 05 — Deletes ac line trigger and External ÷10 from trigger source.

Single Time Base



7B50A

Time Base

7B50A

- 5 ns/div to 5 s/div Calibrated Time Base
- Triggering to 150 MHz
- Variable Trigger Holdoff
- Peak-to-Peak Auto Triggering
- Single-Sweep Operation

The easy-to-use 7B50A Time Base is recommended for use with 7600 Series Mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000 Series Mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

This time base features expanded capability in maximum triggering frequency — now 150 MHz — and variable trigger holdoff — for stability on lengthy asynchronous data trains.

Pushbutton positions select triggering mode, coupling method, and source. For routine applications, hands-off triggering is accomplished by actuating three switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE. The P-P AUTO MODE provides a base line trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of + or — SLOPE this mode is automatic. The other triggering positions are useful for specific applications.

Ac Lf REJ attenuates undesirable trigger components below 30 kHz. Ac Hf REJ attenuates components above 50 kHz, which can cause triggering problems during low-frequency applications. Single-sweep functions with lighted READY indicator and manual reset are associated with the trigger mode controls.

X-Y displays are available with Option 02 installed. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B50A. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

Sweep Rates — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE allows continuous sweep rate selection between steps.

Sweep Accuracy — Measured over center 8 div, +15°C to +35°C, with any 7000 Series Mainframe. Derate accuracies by an additional 1% each for 0°C to +50°C.

Time/Div	Unmagnified	Magnified
5 s/div to 1 s/div	4%	*
0.5 s/div to 0.5 μs/div	2%	3%
0.2 μs/div to 0.05 μs/div	3%	4%

*Unspecified

Trigger Holdoff Time —

MIN Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
	0.5 μs/div to 50 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster	

Triggering —

Sensitivity (AUTO and NORM modes)

Coupling	Triggering Frequency Range[1]	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
Ac Lf REJ[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
Ac Hf REJ	30 Hz to 50 kHz	0.3 div	50 mV
Dc[3]	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV

[1] *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

[2] *Will not trigger on sine waves of less than 8 div INT, or 3 V EXT, at or below 60 Hz.*

[3] *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Sensitivity (P-P AUTO MODE) (Ac or Dc Coupling)

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 150 MHz	1.5 div	375 mV

Option 02

X-Y Phase Shift (Determined by the circuitry in mainframe) — For mainframes without X-Y horizontal compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

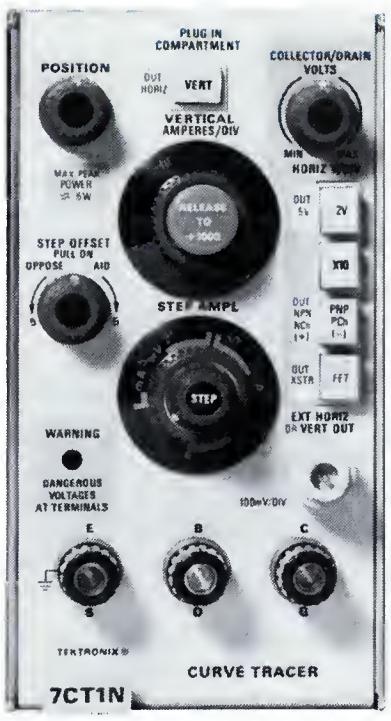
ORDERING INFORMATION

Order 7B50A Time Base $790

7B50A OPTION

Order Option 02, X-Y . . . . . Add $100

Curve Tracer and Readout Unit



7CT1N

Curve Tracer

7CT1N

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

The 7CT1N Curve Tracer Plug-in displays characteristic curves of small-signal semiconductor devices to power levels up to 0.5 W. The 7CT1N operates in horizontal or vertical compartments of 7000 Series Oscilloscopes.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Max Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±20%. Max short-circuit current, within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light, indicating that dangerous voltages may exist at the test terminals, appears on the front panel.

STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μA/step to 1 mA/step, 1-2-5 sequence. Max current (steps plus aiding offset) is 15X amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least 5X amplitude setting.

FET Mode — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is 15X amplitude setting, 13 V max. Source impedance is 1 kΩ ± 1%.

Accuracy — Incremental: within 3% between steps. Absolute: within ± (3% + 0.3X amplitude setting.)

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in 1 step increments between 0 and 10.

Offset — Selectable to 5 steps. Polarity aids or opposes the step polarity.

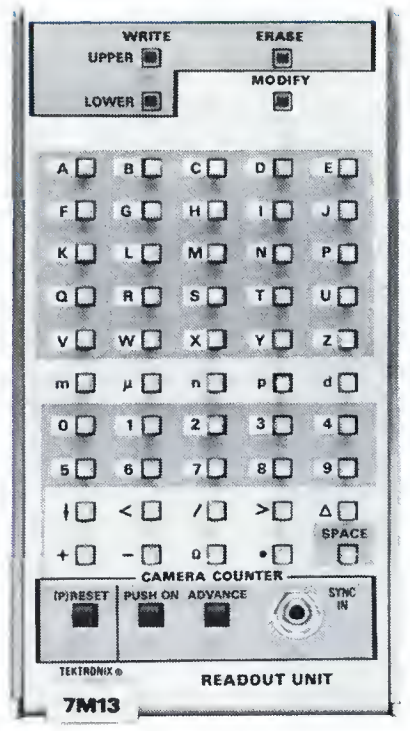
Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the 1X mode.

Vertical Display Accuracy — Within 5% in the 1X mode. Within 5% ±0.2 nA per displayed horizontal volt in the ÷1000 mode.

Horizontal Deflection Factors — Selectable: 0.5 V, 2 V, 5 V, or 20 V.

Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in is a vertical or horizontal amplifier with a 100 mV/div deflection factor and an input R of at least 50 kΩ when it is used in the horizontal compartment.

Order 7CT1N Curve Tracer $1240



7M13

Readout Unit

7M13

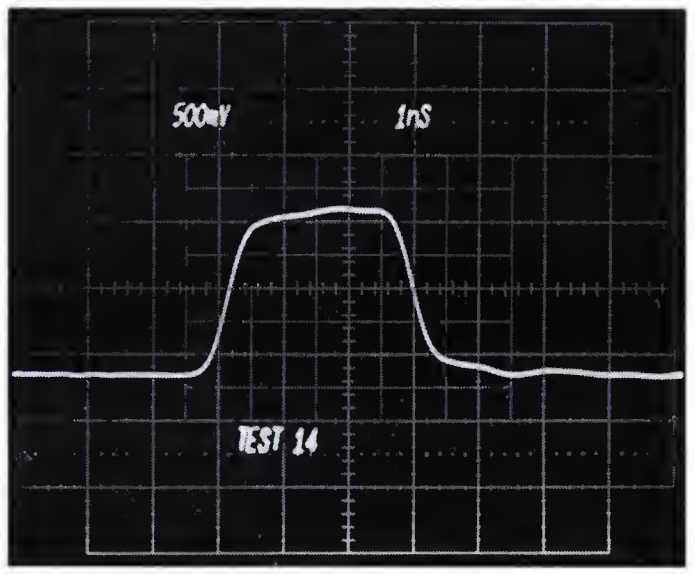
Easy and Convenient Identification of Photographed Displays

Automatic Sequence Advance with Each Camera Exposure

The 7M13 Readout Unit provides front-panel keyboard operation for convenient access to the crt readout characters. Up to ten alphanumeric characters can be displayed at the top and/or at the bottom of the crt. The 7M13 is designed for use in all 7000 Series Mainframes with crt readout. A remote-advance cable is supplied with the 7M13 to connect it to the shutter x-sync connector of the C-50 Series Cameras. An optional cable is available for cameras using an ASA connector for x-sync.

Included Accessory — Remote-advance cable (012-0339-01).

Order 7M13 Readout Unit $840



The photograph above was identified as TEST 14 by using the 7M13 in 7834 Oscilloscope.

Optional Accessory — Remote-advance cable with ASA connector for camera x-sync

Order 012-0364-01 . . . . . $18

Digital Delay

7D11 Digital Delay Unit

7D11

- Delay by Time or Events
- Digital Delay Readout to 7½ Digits
- 100 ns to 1 s Delay Time
- 1 ns Resolution
- 2.2 ns Delay Time Jitter
- 0.5 ppm (±2 ns) Accuracy
- Delay Interval CRT Display

The 7D11 Digital Delay Plug-in gives stable delayed triggers for measurements requiring low jitter. The 7D11 also provides precision time delays. The 7D11 may be used in any compartment of a 7000 Series Mainframe equipped with crt readout. It provides a variety of outputs.

The delay-by events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

In the delay-by-events, the 7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see fig 2).

An accurate and jitter-free delay-by-time is very useful when working with digital logic, pcm telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

When the 7D11 is installed in a vertical compartment, the CRT can display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D11 triggers on. From a vertical compartment, the 7D11 can trigger a time base such as 7B80, 7B53A, or another 7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates a display similar to the "A Intensified by B" mode of conventional delayed sweep (see fig 2). When used in the A horizontal compartment, the 7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1 MHz timing standard through the EXT 1 MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc, the CRT readout would display the "one-way-trip" time.

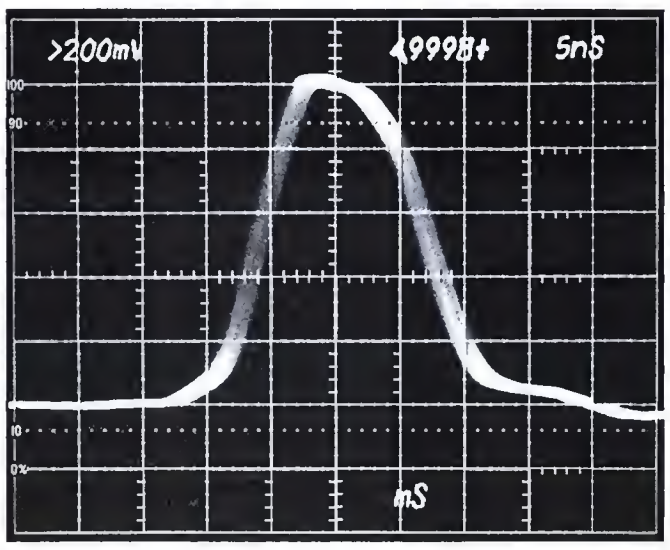


Fig 1. Delay-by-time. A 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

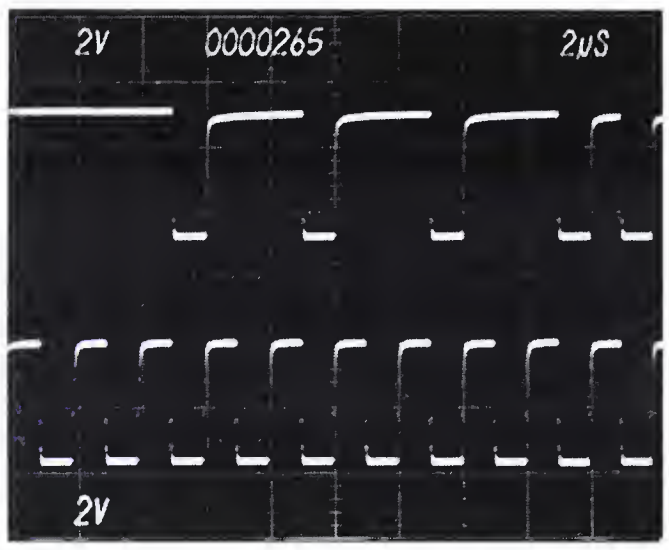


Fig 2. Delay-by-events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.

EVENTS DELAY

Events Delay Range — One to 10^7 events.
Delay Increment — One event.
Insertion Delay — 35 ns ±5 ns.
Recycle Time — Less than 500 ns.
Max Event Frequency — At least 50 MHz.

TRIGGERING

	External Trigger			
Source	Int, Line, Ext, Ext ÷10			
Coupling	Dc, Ac, Ac Lf Rej, Ac Hf Rej			
Max Input Voltage	250 V Dc + peak Ac			
Level Range	±1.75 V in Ext ±17.5 V in Ext ÷10			
Input R and C	1 MΩ ±5%, 20 pF ±2 pF			
Sensitivity	Coupling	Frequency Range	Min Signal Required	
			Int	Ext
	Ac	30 kHz-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV
	Ac Lf Rej*	30 kHz-10 MHz 150 kHz-10 MHz 10 MHz-50 MHz	0.3 div — 1.0 div	— 150 mV 750 mV
	Ac Hf Rej	30 Hz-50 kHz	0.3 div	150 mV
	Dc	Dc-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV

*Will not trigger on sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

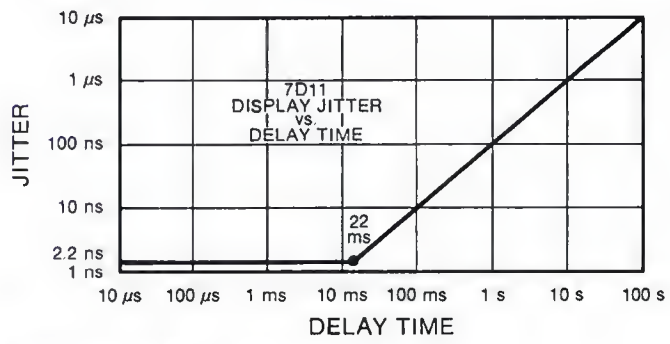
	Events Start Trigger
Source	External Only
Coupling	Dc Only
Max Input Voltage	150 V dc + peak ac
Level Range	±3 V
Input R and C	1 MΩ within 5%, 20 pF ± 2 pF
Sensitivity	100 mV minimum, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.

TIME DELAY

Digital Delay Range — Normal mode: 100 ns to 1 s in 100 ns increments. Echo mode: 200 ns to 2 s in 200 ns increments.

Analog Delay — Continuously variable from 0 to at least 100 ns, accuracy within 2 ns of indicated delay.

Jitter with Internal Clock — 2.2 ns or delay time x 10^{-7}, whichever is greater.



Insertion Delay — Zero within 2 ns.

Recycle Time — Less than 575 ns.

Time Base — 500 MHz oscillator phase-locked to internal or external clock.

Internal Clock — 5 MHz crystal oscillator. Accuracy is 0.5 ppm.

External Clock — 1 MHz within 1%, ac coupled, 50 Ω.

OUTPUTS

Delayed Trigger Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Rise time into 50 Ω load: 2 ns or less. Fall time into 50 Ω load: 5 ns or less. Pulse width: 200 to 250 ns.

Delay Interval Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Rise time into fall time: 5 ns or less. Accuracy: equal to delay interval less 20 to 30 ns.

READOUT

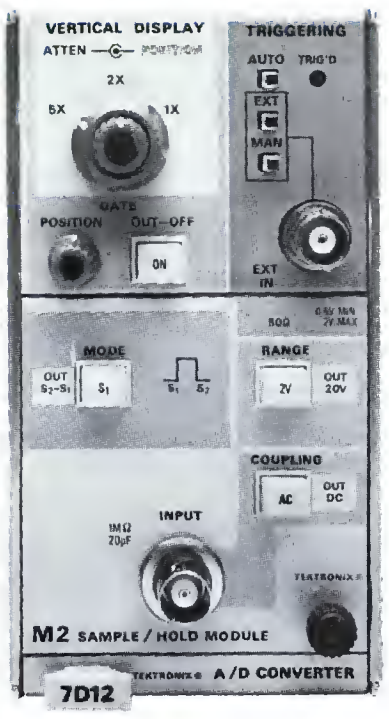
Display — 7½ digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the FINE DELAY (ns) setting.

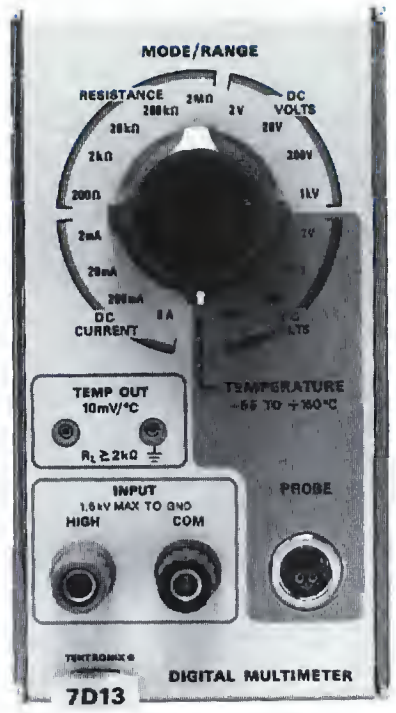
Order 7D11 Digital Delay Unit $2585

A/D Converter and Digital Multimeter

7D12/M2 A/D Converter and Sample/Hold Module

- Automatic, Manual, or External Triggering
- Automatic Polarity and Overrange Indicators
- Oscilloscope-controlled Sampling DVM
- 10 ns Aperture Uncertainty
- Input Signal and Sample Points Displayed on CRT
- 3½ Digit CRT Readout
- 1 mV Resolution
- 25 MHz Bandwidth
- 0-to-2 V and 0-to-20 V Input Range, 200 V with P6055 Probe





The 7D12 is designed for use with all 7000 Series Oscilloscope Mainframes with CRT readout.

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together, providing a visual indication of where the sample(s) is taken. In the S_1 mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken, and the voltage amplitude, from the 0 V level, is digitally displayed on the CRT readout. In the S_2-S_1 mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the CRT readout.

Sample-gate Display Amplitude — 2 div, rise time and fall time 5 ns or less.

Analog-signal Display — Bandwidth is dc to 25 MHz (dc-coupling), 3.4 Hz to 25 MHz (ac-coupling). Vertical sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

Input R and C — 1 MΩ and 20 pF.
Max Input Voltage — 100 V peak.

Measurement Readout — 0 to 20 V in two ranges. 3½-digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 Probe.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Aperture Uncertainty — 10 ns or less.

Pulse-width Sample Time (S_2-S_1 mode) — 30 ns to 5 ms with repetitive signal. 150 μs to 5 ms with single-shot signal.

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

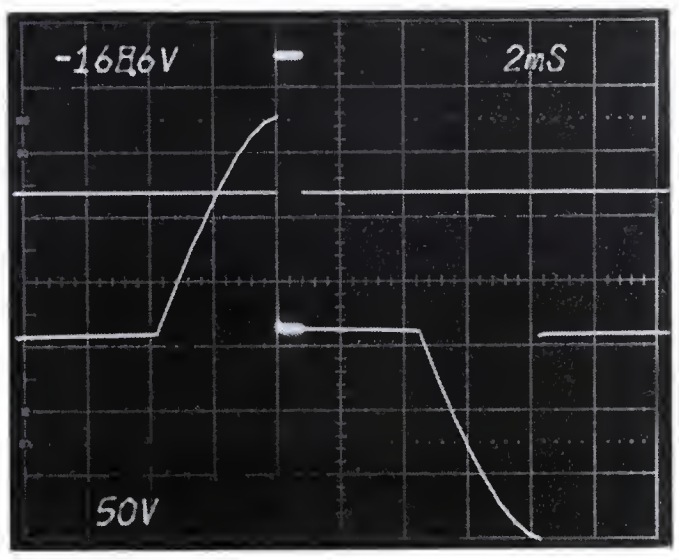
Settling Time — 40 ns.

Accuracy without Probe (40 ns after Input Signal Step Function)

Temperature Range	S_1 Mode	S_2-S_1 Mode
+20°C to +30°C	±0.15% of p-p input voltage, ±0.1% of reading, ± 2 counts, ± % of ac decay*	±0.25% of p-p input voltage, ±0.15% of reading, ± 2 counts, ± % of ac decay*
+15°C to +40°C	±0.25% of p-p input voltage, ±0.2% of reading, ± 3 counts, ± % of ac decay*	±0.35% of p-p input voltage, ±0.25% of reading, ± 3 counts, ± % of ac decay*

*Applicable when M2 is ac-coupled.

Included Accessory — 3.5 ft P6055 Probe package (010-6055-01).



Sample and Hold DVM measures difference voltage (−168.6 V) between two points on complex waveform. Gate waveform indicates two points: leading and trailing edges where voltage difference is made.

ORDERING INFORMATION

7D12 A/D Converter (Module not included	$1325
M2 Sample/Hold Module	$1165
Option 02 without P6055	Sub $120

7D13 Digital Multimeter

- Temperature Mode
- 1.5 kV Max Common-mode Voltage
- Probe Measures Temperature or Voltage
- 3½ Digit CRT Readout

The 7D13 is a digital multimeter designed for use in all 7000 Series Oscilloscope Mainframes with CRT readout. The 7D13 functions in any compartment.

The 7D13 measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6058 voltage/temperature probe. The temperature probe functions regardless of 7D13 mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 V). Temperature may be measured simultaneously along with any other function. Almost any npn transistor may be used as a separate sensor to make small-space "free air" measurements.

When the 7D13 is used, the character generator traces out a 3½ digit display on the CRT and a legend for units like kΩ, mA, °C.

Dc Voltage Range — 0 to 1000 V in four ranges. 3½ digit presentation of 1.999 V, 19.99 V, 199.9 V, and 1000 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +40°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Max safe input is 1.5 kV peak between either contact and ground, 1.0 kV peak between voltage contacts.

Dc Current Range — 0 to 2 A in four ranges. 3½ digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +40°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Max input is 3 A (fuse protected). Input impedance is 0.2 V/full scale current +0.3 Ω.

Resistance Range — 0 to 2 MΩ in five ranges. 3½-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +40°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range — −55°C to +150°C in one range. 3½ digit presentation to +150°C. Accuracy (+5°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Accuracy (0°C to +50°C ambient) is ±2°C from −55°C to +125°C, ±3°C above +125°C.

Settling Time — 1.5 s or less (voltage, current, and resistance modes).

Polarity — Automatic Indication.

Max Common-mode Voltage — 1.5 kV peak between two terminals and ground.

Normal-mode Rejection Ratio — At least 30 dB at 60 Hz, increasing at 20 dB/decade.

Common-mode Rejection Ratio — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

Overrange Indication — When overrange occurs, the readout blinks and the most significant digit displays a 2.

Recycle Time — 5 measurements per second.

Temperature Out — 10 mV/°C into a load of at least 2 kΩ.

Included Accessories — P6058 Voltage/Temperature Probe package (010-0260-00); pair of test leads (003-0120-00).

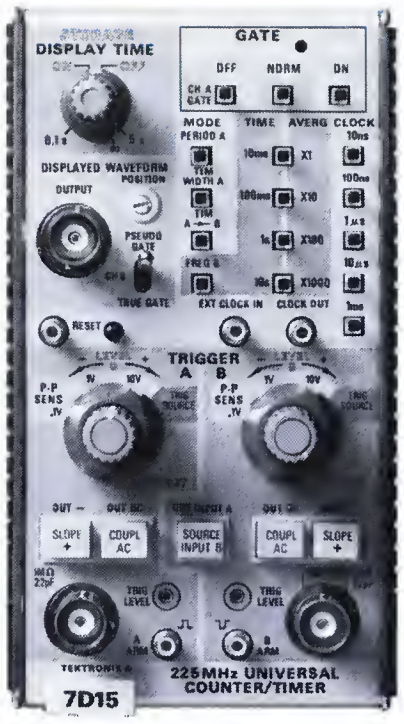
ORDERING INFORMATION

Order 7D13 Digital Multimeter	$985

7D13 OPTION

Order Option 02 without P6058 Probe	Sub $50

Universal Counter/Timer



7D15

225 MHz Counter/Timer

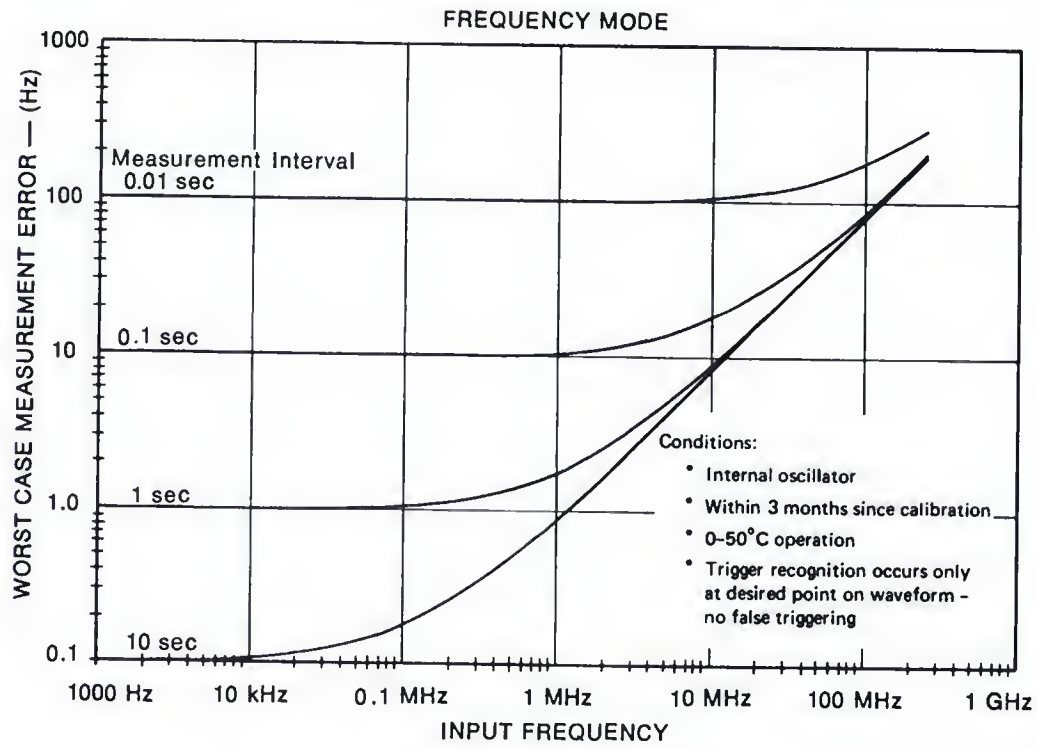
7D15

- Oscilloscope-controlled Time and Frequency Measurements
- 10 ns "Single-shot" Time Interval Measurement Resolution
- Time Interval Averaging
- CRT Display of Counting Interval
- 10 ps Period-Averaging Resolution
- Frequency Measurements Directly to 225 MHz
- Signal Conditioning via Mainframe Trigger Source

Modes of Operation

Frequency Mode	Range	Dc to 225 MHz Resolution 0.1 Hz maximum
	Accuracy	$\epsilon_{freq(Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T}$
Period and Multi-Period Mode	Range	10 ns to 10^5 seconds with averaging times of X1 to X1000 in decade steps. Resolution: 10 picoseconds maximum
	Accuracy	$\epsilon_{period(s)} = \pm TB \cdot P_{in} \pm \frac{10^{-9}}{M} \pm \frac{2E_{npk}}{\frac{dv}{dt} \cdot M} \pm \frac{P_{ck}}{M}$
Time Interval TI and (TI Average) Mode	Range	6 ns to 10^5 seconds with averaging times of X1 to X1000. 0.1 ns resolution (usable)
	Accuracy Worst Case (Nominal)	$\epsilon_{TI(s)} = \pm TB \cdot P_{in} \pm \frac{P_{ck}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	Range	10^{-7} to 10^4
Manual Stop Watch	Range	0 to 10^5 seconds
Totalize, Ch B	Range	0 to 10^8 counts

NOTE: Formulas given where ϵ is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period or time interval of unknown signal; M is the number of averages given; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{npk} equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second). These formulas were used to develop the associated charts.



The 7D15 is a universal counter/timer designed for use in all 7000 Series Oscilloscope Mainframes with CRT readout.

The 7D15 offers all the measurement capabilities of the counter/timer, such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

Three displays, the pseudo gate, CH B Schmitt trigger output, and true gate, are selected by a 7D15 front panel switch and are also available at a front panel connector.

The 7D15 can also be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, visually selective measurements can be made at any point on the CRT display.

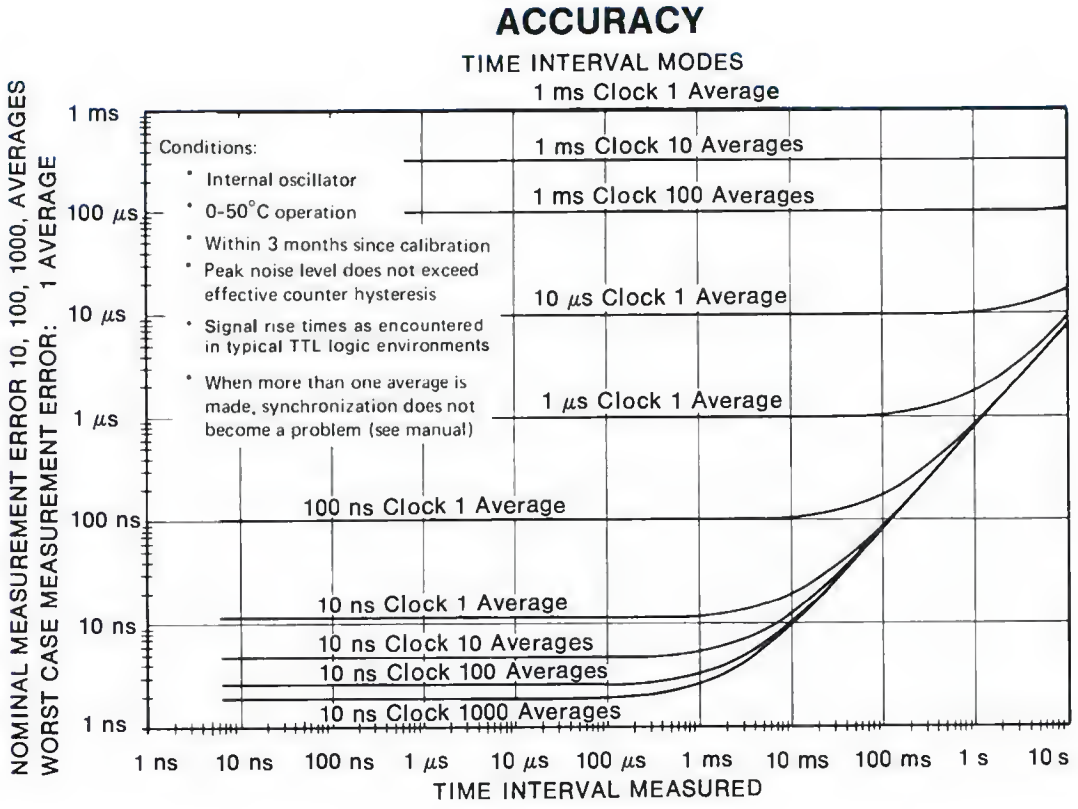
Two identical high-speed trigger circuits provide complete signal processing. Identical trigger circuits also allow single-shot time interval measurements to be made with 10 ns resolution. With repetitive signals, time interval averaging will increase the accuracy of a measurement by a factor of ten or more.

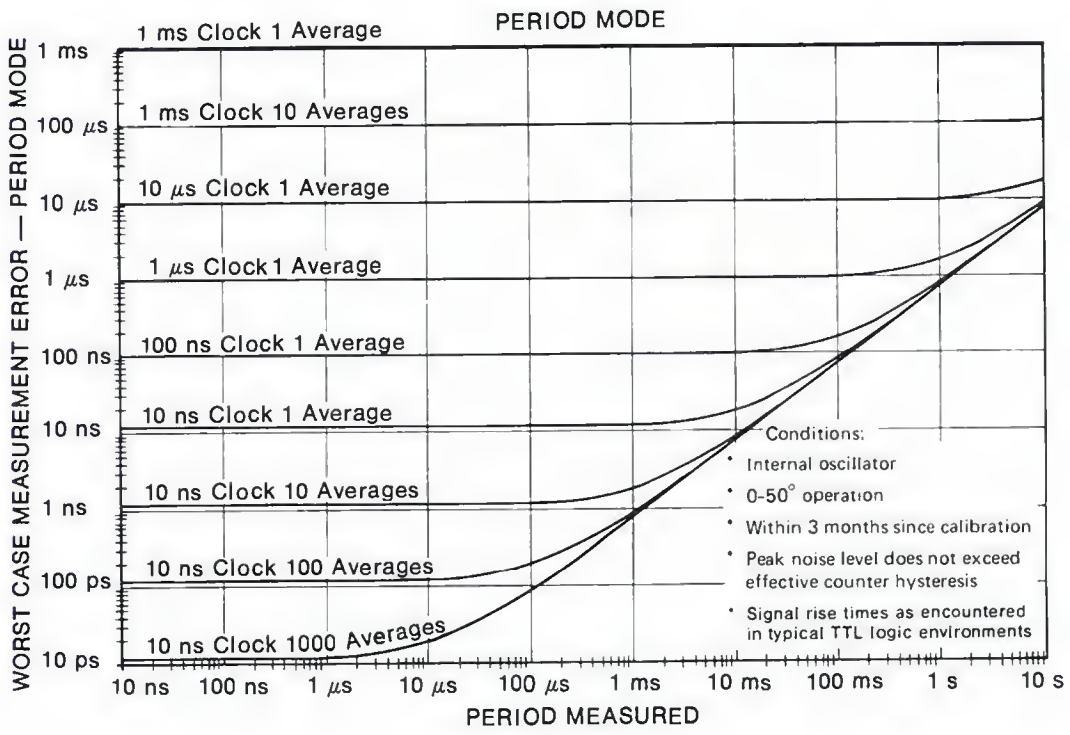
The 7D15 has high resolution because of a 10 ns clock, one of five clock positions obtainable from the front panel. A front panel Clock Out connector makes the selected clock signal available at a front-panel connector. This provides a time mark function that is TTL compatible and will drive a 50 Ω load.

The Ext Clock In connector allows an external 1 MHz timing standard to be used for measurements requiring a higher degree of accuracy than that provided by the internal time base.

The 7D15 may be used in vertical or horizontal compartments of 7000 Series Mainframes. It provides a full 8 digit CRT display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

ACCURACY





INTERNAL TIME BASE

Crystal Oscillator — Accuracy: within 0.5 ppm (0°C to +50°C ambient). Long-term drift: 1 part or less in 10^7 per month. Oscillator is temperature compensated; no warm up is required.

OUTPUT SIGNALS

Clock Out — Logical 1 $\geq$ +0.5 V into 50 Ω. Logical 0 $\leq$ 0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

A and B Trigger Level — $Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (Internally Connected) — Front-panel switch selects true gate, pseudo gate, or channel B signal out. Position controlled by front-panel screwdriver control.

External Display — Same as internal except position control has no effect.

Display Mode Switch — Allows selection of readout "follow or store."

Display Time — 0.1 to 5 s; also a preset position for infinite display time.

Readout — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a > symbol.

INPUT SIGNAL CH A & B

Frequency Range (CH B only) — Dc-coupled: dc to 225 MHz. Ac-coupled: 5 Hz to 225 MHz.

Sensitivity (CH A and B Inputs) — 100 mV p-p. Trigger source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

Input R and C — 1 MΩ and 22 pF.

Triggering (Preset Position) — Automatically triggers at 0 V.

Level Control Range (CH A and B Inputs) — 100 mV range: ±500 mV. 1-V range: ±5 V. 10-V range: ±50 V.

Arming Inputs — Input R and C: 10 kΩ and 20 pF. Sensitivity arm A: logical 1 $\geq$ +0.5 V, logical 0 $\leq$ +0.2 V. Sensitivity arm B: logical 1 $\leq$ +0.2 V, logical 0 $\geq$ + 0.5 V.

External Clock-In — 20 Hz to 5 MHz.

Reset Front Panel — Reset readies the instrument. All counters are affected, including averaging circuits.

Included Accessories — Two cables RF 44 in (012-0403-00, Sealectro to BNC connector).

Order 7D15 Universal Counter/Timer $2680

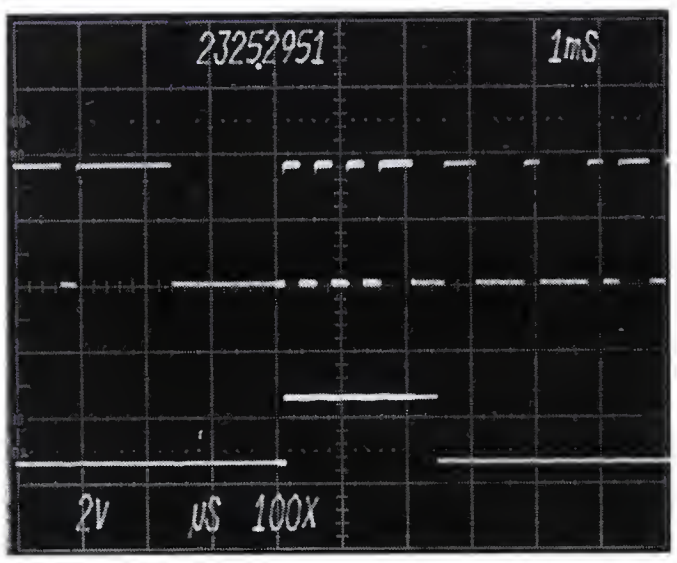


Fig. 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise *time interval measurement* from third to seventh pulse on CRT display. Counter Ch A is "armed" with leading edge of B gate while Ch B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 μs.

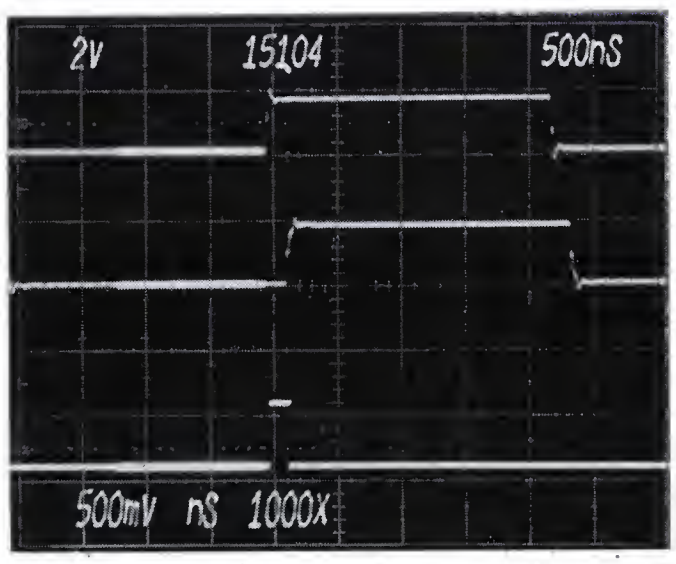


Fig. 2. The *propagation delay time* between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.

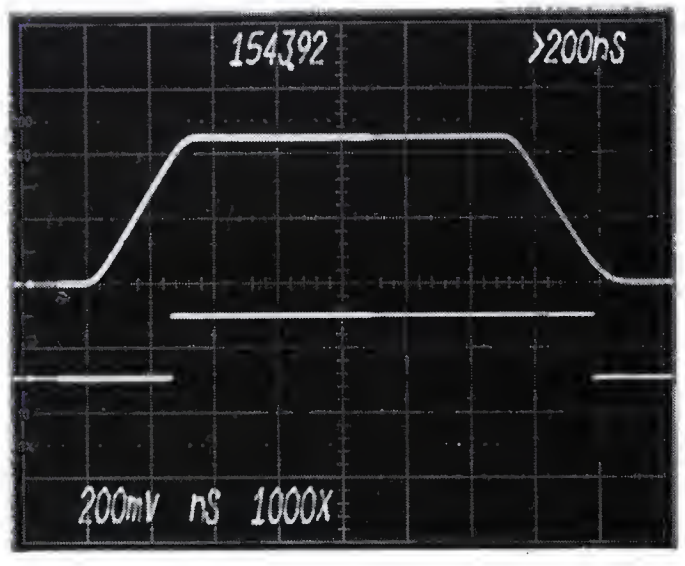
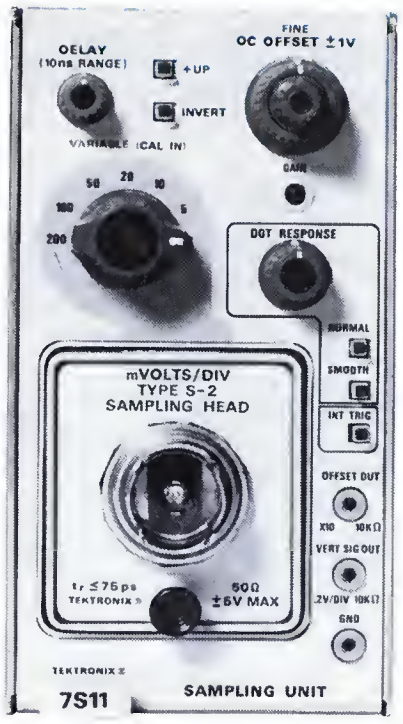


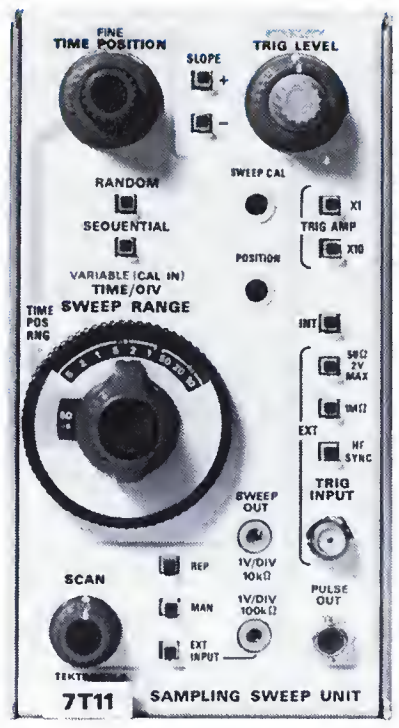
Fig. 3. Independent slope and level control allows the user to *visually select* precise points on the waveform where the counter starts and stops. CRT readout displays the result of 1543.9 ns.

Sampling Units to 14 GHz

7S11



7T11



7S11

2 mV/div to 200 mV/div Calibrated Deflection Factors

Plug-in Sampling Heads

The 7S11 is a single-channel sampling unit. The input configuration employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used in a variety of combinations. Single-channel sampling uses one 7S11 with a 7T11 Time Base. Two 7S11s and one 7T11 provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

CHARACTERISTICS

Deflection Factor — 2 units/div to 200 units/div in 7 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous (extends deflection factor from 1 unit/div or less to at least 400 units/div). Deflection factor is determined by the plug-in sampling head.

Bandwidth — Determined by the sampling head.

Input Impedance — Determined by the sampling head.

Dc Offset — Range, +1 V to −1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.

Delay Range — At least 10 ns for comparing two signals in a dual-trace application.

Memory Slash — 0.1 div or less at 20 Hz.

Vertical Signal Out — 200 mV per displayed div within 3%.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

Order 7S11 Sampling Unit without Sampling Head $1580

7T11

10 ps/div to 5 ms/div Calibrated Time Base

Random or Sequential Sampling

Equivalent or Real Time Sampling

No Pretrigger Required

The 7T11 Sampling Time Base provides equivalent-time and real-time horizontal deflection for single- or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from ≃ 10 Hz (sequential mode) to above 12.4 GHz.

CHARACTERISTICS

Time/Div Range — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated VARIABLE is continuous between steps to at least 4 ps/div.

Time Position Range — Equivalent time is 50 ns to 50 μs in 4 steps; real time is 0.5 ms to 50 ms in 3 steps.

Time/Div Accuracy — Within 3% for all time/div settings over center 8 cm.

TRIGGERING

Ext 50 Ω Input — Frequency range is dc to 1 GHz in 1X TRIG AMP mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 TRIG AMP, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 50 Ω within 10%. Max input voltage is 2 V (dc + peak ac).

Ext 1 MΩ Input — Frequency range is dc to 100 MHz in X1 TRIG AMP mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz) in X1 TRIG AMP, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 1 MΩ within 5%. Max input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a min 5 V p-p).

Ext HF Sync — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Max input voltage is 2 V p-p.

Int Trigger Source (Sine-wave Triggering)* — Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP; 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 TRIG AMP; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 TRIG AMP.

*Trigger circuits will operate to dc with pulse triggering, except for Hf Sync.

Random Mode Trigger Rate — 100 Hz min.

Display Jitter — Measured under optimum trigger conditions with TIME/DIV switch clockwise.

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

Pulse Out — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns rise time or less.

Trigger Kickout — 2 mV or less into 50 Ω (except HF SYNC).

Display Scan Rate — Continuously selectable from at least 40 sweeps/s to less than 2 sweeps/s.

External Scan — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ within 10%. Max input voltage is 100 V (dc + peak ac).

Sweep Out — 1 V/div within 2%. Source R is 10 kΩ within 1%.

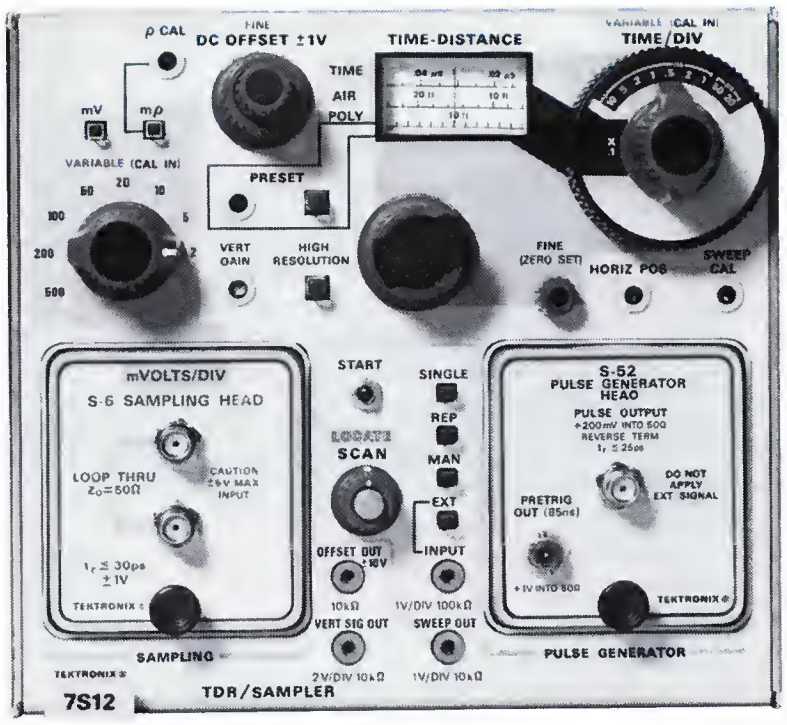
Ambient Temperature — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

INCLUDED ACCESSORIES

42 in BNC 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); SMA (3 mm) male to BNC adapter (015-1018-00); SMA (3 mm) male to GR874 adapter (015-1007-00).

Order 7T11 Sampling Sweep Unit . . . $3940

45 ps TDR or General-Purpose Sampler



7S12

45 ps TDR or a General-purpose Sampler

6 Plug-in Sampling Heads Available

2 Plug-in Pulse Sources Available

1 Trigger Recognizer Head Available

The 7S12 is a combined vertical-horizontal, double-width plug-in for high resolution TDR or general purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system rise time of 45 ps (return from short-circuit termination) and distance range to 290 ft in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 mρ/div to 500 mρ/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line TDR using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 ft (air line) and discontinuities to twice this distance may be viewed. System rise time with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

CHARACTERISTICS

System Performance with S-6 and S-52

System Rise Time — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distance to at least 400 ft (air line). Time range is at least 0.9 μs round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude — At least +200 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω, feed-through signal channel (termination supplied). SMA (3 mm) connectors.

Jitter — Less than 10 ps (without signal averaging).

Aberrations — +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

TDR System Performance with S-5 and S-54

System Rise Time — 1.5 ns or less for the displayed reflection from a short-circuited test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distances to 4900 ft air line, 3240 ft solid polyethylene. Time range is 20 μs round trip.

Pulse Amplitude — At least +400 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω test line connection (cable and T supplied). BNC connectors.

Jitter — Less than 20 ps (without signal averaging).

Aberrations — +4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.

OTHER 7S12 CHARACTERISTICS

Vertical Scale — Calibrated in mρ (reflection coefficient 10^{-3}) and mV from 2 to 500 units/div in 8 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous between steps.

Resolution — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

Dc Offset Range — +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

Time/Distance — Tape dial is calibrated in time and distance: full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

Time/Div — 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes — Repetitive or single sweep, manual or external scan.

Signal Outputs — Pin jacks provide both vertical signal and sweep outputs.

INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR slide rule (003-0700-00).

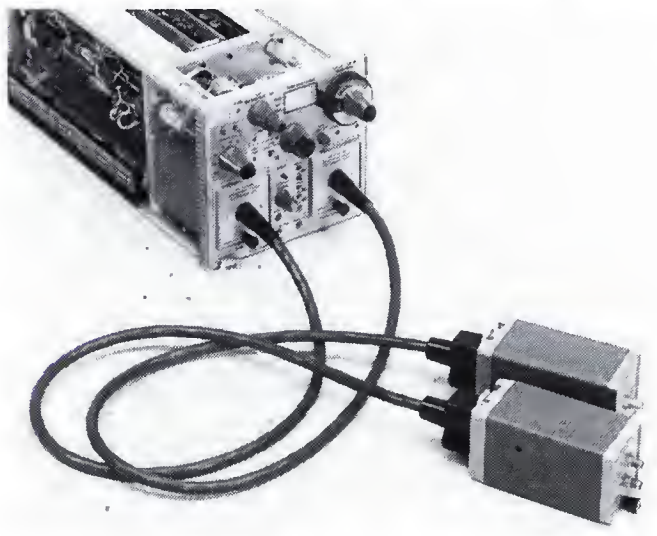
Order 7S12 TDR Sampling Unit
(tape dial in feet) without
Sampling Heads **$2925**

Order Option 03 Tape Dial Change (Meters) **$200**

OPTIONAL ACCESSORIES

Patch Cords — available for the OFFSET OUT, EXT SWEEP INPUT, VERT SIG OUT, and SWEEP OUT jacks of the 7S12, Pin-jack to pin-jack, 0.08 in dia. pin.

Red, 8 in, Order 012-0179-00 ..... **$3.50**
Red, 18 in, Order 012-0180-00 ..... **$3.50**
Black, 8 in, Order 012-0181-00 ..... **$3.50**
Black, 18 in, Order 012-0182-00 ..... **$3.50**
Tape Dial (Calibrated in Feet) Order 331-0273-00 ..... **$12.50**
Tape Dial (Calibrated in Meters) Order 331-0276-00 ..... **$12.50**



3 ft Sampling-Head Extender, Order 012-0124-00 $345
6 ft Sampling-Head Extender, Order 012-0125-00 $410

NOTE: See 1502-1503 Portable TDR Cable Tester on pages 252-253.

Sampling Heads to 14 GHz

S-1

Dc-to-1 GHz Bandwidth

Clean Transient Response

The S-1 Sampling Head is a low noise, 350 ps rise time unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

Rise Time — 350 ps or less.

Bandwidth — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 284 Pulse Generator are +0.5%, —3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; +0.5%, —0.5% or less, total of 1% or less p-p after 5 ns.

Displayed Noise — 2 mV or less, unsmoothed; 1 mV, smoothed.

Signal Range — Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Included Accessories — 5 ns, 50 Ω RG58 A/U cable (017-0512-00); 10X, 50 Ω GR attenuator (017-0078-00).

Order S-1 Sampling Head $1035

S-2

Dc-to-4.6 GHz Bandwidth

Displayed Noise Less than 6 mV (Unsmoothed)

The S-2 Sampling Head is a 75 ps rise time unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

Rise Time — 75 ps or less.

Bandwidth — Equivalent to dc to 4.6 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 284 Pulse Generator are +5%, —5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, —2% or less, total of 4% or less p-p after 2.5 ns.

Displayed Noise — 6 mV or less, unsmoothed; 3 mV, smoothed.

Signal Range — Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 200 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Included Accessories — 5 ns, 50 Ω RG213/U cable (017-0502-00); 10X, 50 Ω GR attenuator (017-0078-00).

Order S-2 Sampling Head $1215

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe,
Order (Std) 015-0041-00 . . . . . $115
P6056 10X Passive Probe,
Order (Std) 010-6056-03 . . . . . $120
P6057 100X Probe,
Order (Std) 010-6057-03 . . . . . $125
Coupling Capacitor, GR874-K,
Order 017-0028-00 . . . . . $60
Power Divider GR874-TPD,
Order 017-0082-00 . . . . . $225
GR to BNC Adapter,
Order 017-0063-00 . . . . . $25

S-3A

Compact, 4.5 Ft, 100 kΩ, 2.3 pF Probe

Dc-to-1 GHz Bandwidth

Displayed Noise Less than 3 mV (Unsmoothed)

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

Rise Time — 350 ps or less.

Bandwidth (Probe Only) — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response (Probe Only) — Aberrations in the first 2 ns following a step are +8%, —2% or less, total of 10% or less p-p, +1%, —1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

Displayed Noise (Probe Only) — 3 mV or less referred to probe tip (includes 90% of dots).

Signal Range — Variable dc offset allows signals between +1 V and —1 V, 1X range, or +2 V and —2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.

Included Accessories — 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½ in ground lead (175-1017-00); 12½ in ground lead (175-1018-00); 3 in cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01); carrying case (016-0121-01); 3 in elec lead (175-0849-00); 6 in elec lead (175-0849-01).

Order S-3A Sampling Head $1580

S-4

25 ps Sampling Head

Dc-to-14 GHz Equivalent Bandwidth

Displayed Noise Less than 5 mV (Unsmoothed)

The S-4 Sampling Head is a 25 ps rise time unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

Rise Time — 25 ps or less.

Bandwidth — Equivalent to dc to 14 GHz at 3 dB down.

Transient Response — Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are —10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, —0%, +10% or less, total of 10% or less p-p with 284 pulse displayed; after 25 ns, —2%, +2% or less, total of 4% or less p-p.

Displayed Noise — 5 mV or less, unsmoothed; 2.5 mV, smoothed (includes 90% of dots).

Signal Range — Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

Input Characteristics — Nominally 50 Ω. Safe overload ±5 V. SMA (3 mm) input connector.

Included Accessories — 2 ns cable with SMA connectors (015-1005-00); 10X 50 Ω SMA attenuator (015-1003-00); GR874 to SMA male adapter (015-1007-00); SMA male-to-male adapter (015-1011-00); 5/16 in wrench (003-0247-00).

Order S-4 Sampling Head $2365

S-5

1 MΩ, 15 pF Input Impedance

Passive Probe

Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns rise time sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns rise time at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Rise Time — S-5 only, 1 ns or less; with 3.5 ft P6010, 1 ns or less.

Bandwidth — Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.

Transient Response — S-5 only (driven with a 50 Ω source terminated in 50 Ω): aberrations +2.5%, —5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, —1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft probe, properly compensated): aberrations +5%, —5% or less, total of 10% or less p-p within 25 ns after step; +1%, —1% or less, total of 2% or less p-p thereafter.

Displayed Noise — S-5 only, 500 μV or less (includes 90% of dots). S-5/P6010, 5 mV or less (includes 90% of dots).

Signal Range — S-5 only: dc coupled, 1 V p-p from +1 V to —1 V; ac coupled, 1 V p-p. S-5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.

Input Characteristics — S-5 only, 1 MΩ within 1% paralleled by 15 pF. S-5/P6010, 10 MΩ paralleled by approx 10 pF.

Attenuator Accuracy — Probe attenuation is 10X within 3%.

Included Accessories — P6010 Probe package (010-0188-00), 50 Ω termination (011-0049-01).

Order S-5 Sampling Head $1105

OPTIONAL ACCESSORIES

Probe Tip-to-BNC Adapter,
Order 013-0084-01 . . . . . $8
Probe Tip-to-GR Adapter,
Order 017-0076-00 . . . . . $32
Probe Tip-to-GR Terminated Adapter,
Order 017-0088-00 . . . . . $44

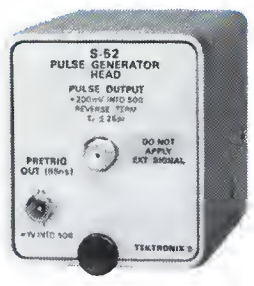
SAMPLING HEAD CHARACTERISTICS

	S-1	S-2	S-3A	S-4	S-5	S-6
Bandwidth	Dc-1 GHz	Dc-4.6 GHz	Dc-1 GHz	Dc-14 GHz	Dc-350 MHz	Dc-11.5 GHz
Risetime	≤350 ps	≤75 ps	≤350 ps	≤25 ps	≤1 ns	≤30 ps
Input Impedance	50 Ω	50 Ω	100 kΩ	50Ω	1 MΩ	50 Ω feed thru
Noise: Smoothed	≤1 mV	≤3 mV	—	≤2.5 mV	≤500 μV	—
Unsmoothed	≤2 mV	≤6 mV	≤3 mV at probe tip	≤5 mV	≤5 mV	≤5 mV
Connector	GR	GR	Probe	SMA (3 mm)	BNC	SMA (3 mm)

TIMING HEAD CHARACTERISTICS

	S52	S53	S54
Bandwidth	—	Dc-1 GHz trigger recognizer	—
Risetime	≤25 ps	—	≤1 n
Application	high resolution TDR	general purpose sampling	medium resolution TDR

Sampling, Trigger Recognizer and Pulse Generator Heads



S-6

30 ps Rise Time

Displayed Noise Less than 5 mV (Unsmoothed)

Loop-through Input

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

Rise Time — 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

Bandwidth — Equivalent to dc to 11.5 GHz at 3 dB down.

Transient Response — Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Displayed Noise — 5 mV or less, measured tangentially.

Signal Range — +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

Input Characteristics — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Max safe overload is ±5 V.

Included Accessories — 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) female-to-female adapter (015-1012-00); SMA male-to-GR874 adapter (015-1007-00); combination wrench (003-0247-00).

Order S-6 Sampling Head $2040

OPTIONAL ACCESSORIES FOR SAMPLING HEADS with SMA (3 mm) Connectors

2X 50 Ω Attenuator, Order 015-1001-00 . . . . . $120
5X 50 Ω Attenuator, Order 015-1002-00 . . . . . $120
10X 50 Ω Attenuator, Order 015-1003-00 . . . . . $120
50 Ω Termination, Order 015-1004-00 . . . . . $60
2 ns 50 Ω Signal Cable, Order 015-1005-00 . . . . . $80
5 ns 50 Ω Signal Cable, Order 015-1006-00 . . . . . $130
Female-to-GR874 Adapter, Order 015-1007-00 . . . . $50
Male-to-GR874 Adapter, Order 015-1008-00 . . . . . $55
Male-to-N Female Adapter, Order 015-1009-00 . . . $50
Male-to-7 mm Adapter, Order 015-1010-00 . . . . . $175
Male-to-Male Adapter, Order 015-1011-00 . . . . . $20
Female-to-Female Adapter, Order 015-1012-00 . . . $16
Coupling Capacitor, Order 015-1013-00 . . . . . $150
50 Ω Power Divider T, Order 015-1014-00 . . . . . $200
500 ps 50 Ω Semirigid Cable, Order 015-1015-00 . . $40
SMA T Adapter, Order 015-1016-00 . . . . . $30
SMA Male-to-BNC Female Adapter, Order 015-1018-00 . . . . . $8
1 ns 50 Ω Cable, Order 015-1019-00 . . . . . $105
SMA Male Short-Circuit Termination, Order 015-1020-00 . . . . . $17.50
SMA Female Short-Circuit Termination, Order 015-1021-00 . . . . . $24
SMA Male 50 Ω Termination, Order 015-1022-00 . . . $32

With BNC Connectors

50 Ω Feed-through Termination, Order 011-0049-01 . . . . . $25
50 Ω Feed-through (5 W), Order 011-0099-00 . . . . . $40
50 Ω 2X Attenuator, Order 011-0069-02 . . . . . $35
50 Ω 2.5X Attenuator, Order 011-0076-02 . . . . . $35
50 Ω 5X Attenuator, Order 011-0060-02 . . . . . $35
50 Ω 10X Attenuator, Order 011-0059-02 . . . . . $35
50 Ω 18 in, Coaxial Cable, Order 012-0076-02 . . . . $35
50 Ω 42 in, Coaxial Cable, Order 012-0057-01 . . . . $15

COMPARISON OF SAMPLING FEATURES

	7S11/ 7T11	7S12	7S14
Maximum Bandwidth	14 GHz	1 GHz	1 GHz
Fastest Risetime	≤25 ps	≤350 ps	≤350 ps
Vertical Sensitivity Range	2-200 mV/div	2-500 mV/div	2-500 mV/div
Sequential Equiv. Sampling	YES	YES	YES
Random Equiv. Sampling	YES	NO	NO
Real Time Sampling	YES	NO	NO
Smoothing	YES	YES	YES
Channels	1 (2 with an additional 7S11.)	1 (2 with an additional 7S11.)	2
TDR	NO (but can be done)	YES	NO (but can be done)
Change-able Heads	YES (vertical only)	YES (horizontal and vertical)	NO
Input Impedance	50 or 1 MΩ (depending on head)	50 or 1 MΩ (depending on head)	50 Ω

S-52

25 ps Rise Time

200 mV into 50 Ω

50 Ω Source

Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution Time Domain Reflectometer.

For tdr applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 32 ft in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

Pulse Output — Rise time is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 800 ns, pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Pretrigger Output — Rise time is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

Output Connectors — Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

Included Accessory — 1 ns, 50 Ω semirigid coax delay line (015-1023-00).

Order S-52 Pulse Generator Head . . . $1460

S-53

Dc-to-1 GHz Operation

10 mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

Input Characteristics — Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

Output Characteristics — Rise time is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

Connectors — Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

Included Accessories — 42 in, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02).

Order S-53
Trigger Recognizer Head $1070

S-54

1 ns Rise Time

Low Aberrations

400 mV into 50 Ω

50 Ω Source

Variable Pretrigger Lead Time

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line Time Domain Reflectometer unit.

Intended for TDR applications, the S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

Pulse Output — Rise time is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base line level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output — Rise time is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

Output Connectors — Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Included Accessories — BNC T connector (103-0030-00); 8 in 50 Ω cable (012-0118-00).

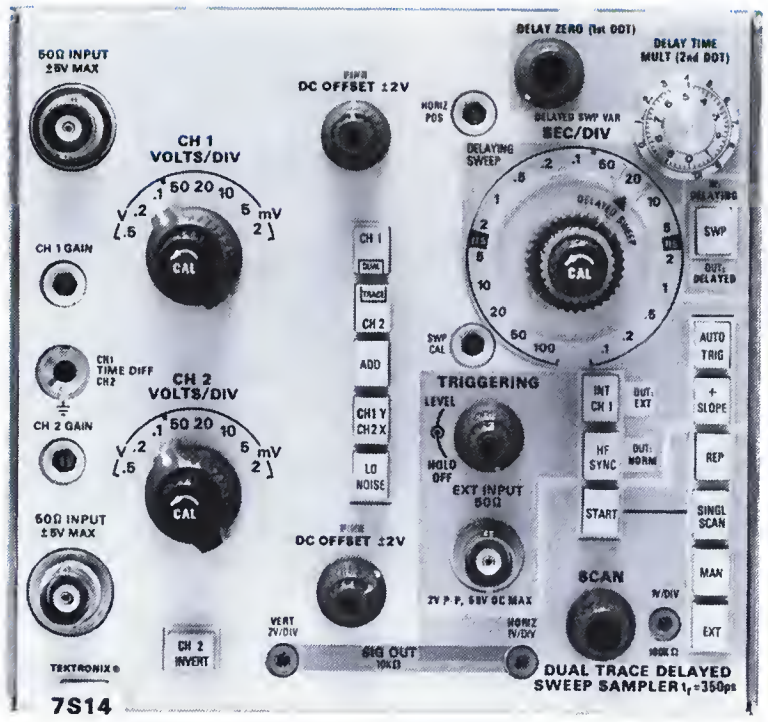
Order S-54 Pulse Generator Head $960

SAMPLING HEAD WEIGHTS (Approx)

	S-1		S-2		S-3A		S-4		S-5	
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	1	0.5	1	0.5	3	1.4	1	0.5	0.6	0.3
Shipping	3	1.4	3	1.4	5	2.3	2	0.9	2	0.9

	S-6		S-52		S-53		S-54	
	lb	kg	lb	kg	lb	kg	lb	kg
Net	1	0.5	0.8	0.3	0.8	0.3	0.8	0.3
Shipping	2	0.9	1	0.5	1	0.5	1	0.5

1 GHz Dual-Trace, Delayed Sweep Sampler



7S14

- Calibrated Delayed Sweep
- Two-dot Measurements
- Dc-to-1 GHz Bandwidth
- Dual Trace, 2 mV Sensitivity
- CRT Readout
- Simplified Triggering
- Operational Ease of a Conventional Oscilloscope

The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in.

Two identical vertical channels provide dual-trace sampling, a two-ramp time base and calibrated delayed sweep.

Front-panel controls are grouped by color, and the control nomenclature is similar to conventional oscillosocpe nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation.

VERTICAL CHANNEL

Modes — Ch 1 only; Ch 2 only; Dual Trace; Ch 1 added to Ch 2; Ch 2 substracted from Ch 1 (Ch 2 INVERT); Ch 1 Vertical (Y), Ch 2 Horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc to 1 GHz.

Rise Time — 350 ps or less.

Step Aberrations — +2%, −4%, total of 6% p-p within first 5 ns, ±1% thereafter, tested with a 284 Pulse Generator.

Deflection Factor — 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Max Input Voltage — ±5 V.

Input Signal Range — 2 V p-p max within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

Channel Delay Difference — Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE

Scan Modes — Repetitive, single, manual, or external.

Delaying Sweep — May be used as the crt time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

Horizontal Signal Output — 1.0 V per div of horizontal deflection; 10 kΩ source resistance.

DELAYING SWEEP

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3%, excluding first one-half div of displayed sweep.

Delayed Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first 9 div of the delaying sweep selected.

Delay Time (2nd Dot) — Adjustable to any position of the time interval represented by 10 div of the delaying sweep selected.

Delay Accuracy — Within ±1% of 10 div when measurement is made within the last 9.5 div.

DELAYED SWEEP

Range — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first one-half div of displayed sweep.

Start Delay — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by 10 div of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

Delay Jitter — Less than 0.05% of the time represented by 1 div of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources — Internal from Ch 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

Auto Trigger Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approx the p-p voltage of the signal.

Holdoff — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

Hf SYNC Mode — For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

Order 7S14 Dual-Trace Delayed Sweep Sampler $4615

5000 Series Instruments

Digital Storage Capability . . . The new 5223 Digitizing Oscilloscope provides digital storage at the touch of a button, intensified pre-trigger viewing, equivalent time sampling, and X-Y displays. This 5000 Series Scope, with optional IEEE-488 interface, is ideal for physical, mechanical and biomedical applications.

Performance Value . . . The 5400 Series is designed for the cost-conscious user as an alternative to the monolithic scope; it gives you 50 MHz bandwidth in both non-store and variable persistence storage mainframes with CRT readout.

Maximum Flexibility . . . The 5100 Series is ideal for low frequency applications such as medical and mechanical measurements requiring up to 2 MHz bandwidth; it gives you unparalleled choices in measurement flexibility such as dual-beam; split-screen, bistable storage displays, differential inputs and spectrum analysis.

Expandability . . . With the 5000 Series Plug-in Oscilloscope, you are making a cost-effective investment in current technology—and insuring yourself a share in the future.

MAINFRAMES

Mainframe/ Display Unit	Page	Beams	Storage	Display Size
5110	142	Single		8 x 10 div (1.27 cm/div)
5111	142	Single	Bistable	8 x 10 div (1.27 cm/div)
5113	143	Dual	Bistable	8 x 10 div (1.27 cm/div)
5115	143	Single	Bistable	8 x 10 div (1.27 cm/div)
5223	136	Single	Digital	8 x 10 div (1.22 cm/div)
5440	138	Single		8 x 10 div (1.22 cm/div)
5441	139	Single	Variable Persistence	8 x 10 div (0.9 cm/div)

SPECIAL-PURPOSE PLUG-INS

Product	Page	Description
5CT1N	237	Semiconductor Curve Tracer
5L4N	249	Low-Cost Spectrum Analyzer
5S14N	148	Dual-Trace Delayed Sweep Sampler

AMPLIFIERS

Product	Page	Type	Minimum Deflection Factor	Bandwidth —3 dB	Cmrr
5A13N	145	Single	1 mV/div	2 MHz	10,000:1
5A14N	144	Four	1 mV/div	1 MHz	
5A15N	144	Single	1 mV/div	2 MHz	
5A18N	144	Dual	1 mV/div	2 MHz	
5A19N	145	Single	1 mV/div	2 MHz	1000:1
5A21N	145	Single (voltage and current)	50 μV/div 0.5 mA/div	1 MHz	100,000:1
5A22N	146	Single	10 μV	1 MHz	100,000:1
5A24N	144	Single	50 mV/div	2 MHz	
5A26	146	Dual	50 μV/dlv	1 MHz	100,000:1
5A38	140	Dual	10 mV/div	35 MHz	
5A48	140	Dual	1 mV/div*	50 MHz	

**Bandwidth is dc to 25 MHz at 1 mV/div and 2 mV/div.*

TIME-BASE PLUG-INS

Product	Page	Type	Sweep Rate	Mag	Single Sweep	Volts/ Div Ext Mode
5B10N	147		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	147	Dual Delaying	A 1 μs to 5 s B 2 μs to 0.5 s	X10 —	Yes —	50 mV and 500 mV
5B40	141		0.1 μs to 5 s	X10	Yes	50 mV
5B42	141	Delaying	A 0.1 μs to 5 s B 0.1 μs to 0.5 s	X10 X10	Yes —	50 mV
5B25N	141	Digitizer	0.2 μs to 5 s	X10	Yes	50 mV

5000 Series Reference

- Low Cost
- 2 MHz, 10 MHz or 50 MHz Bandwidth
- Sampling to 1 GHz
- 0 to 100 kHz Spectrum Analysis
- 7 Oscilloscope Models
- 19 Plug-ins Available
- Digital, Dual-Beam and Storage Displays
- CRT Readout (5400 Series only)
- Large 6.5 inch CRT (8 x 10 div)
- 10 μV/div High Gain Differential Amplifier
- 1 to 8 Trace Capability
- Delayed-Sweep Time Bases
- Y-T or X-Y Operation
- Bench-to-Rack Convertibility

The 5000 Series Oscilloscopes are designed to provide optimum versatility and performance at the lowest possible price.

5100 Series Oscilloscopes

Four 5100 Series Oscilloscopes are available. They include single-beam, dual-beam, and storage displays. The storage display units feature bistable, split-screen storage with large 6.5 inch CRTs that accommodate display units, have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drives both beams.

The 5100 Series features 2 MHz mainframes with large 6.5 inch CRTs that accommodate two vertical deflection plug-ins and one horizontal deflection plug-in. They can be easily converted from bench to rackmount configuration.

To date, 14 plug-ins are available for use with the 5100 Series. Among these are the low-cost 5L4N Spectrum Analyzer for the 0-to-100 kHz frequency range and the 5S14N, a general purpose, 1 GHz dual-trace sampling plug-in.

5223 Digitizing Oscilloscope

You can get the benefits of digital storage, along with the time-tested advantages of a conventional analog scope, in the 10 MHz 5223 Digitizing Oscilloscope. Combined in one powerful, convenient oscilloscope are pushbutton ease, high quality waveform display, pretrigger signal manipulation, and optional GPIB interface, plus real-time analog display capability.

Use the 5223 in the digital storage mode to capture repetitive events at speeds of up to 10 MHz or single-shot events at speeds of up to 100 kHz. The 5223's maximum sample rate is 1 MHz; storage capacity is 1024 bits per vertical compartment.

The digitized display will never fade or bloom, so you get more accurate measurements, more conveniently. High 10-bit vertical resolution gives you an accurate representation of your signals.

5400 Series Oscilloscopes

Two 5400 Series display units are presently available: a single-beam, non-storage display and a variable persistence storage display. Both feature CRT readout of plug-in scale factors, 3 plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series offers 50 MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be external accessed.

PLUG-IN VERSATILITY

19 plug-ins are now available in the 5000 Series Family. All these plug-ins are compatible with the 5400 Series, and all but seven are compatible with 5100 Series Mainframes.

The amplifier plug-ins include single, dual, and four trace units, various differential amplifiers (including one with a current probe input), and a differential comparator amplifier. The time-base plug-ins include single, dual, delayed sweep units, and a digital delay time base.

Three special-purpose plug-ins are also available. The 5L4N is a spectrum analyzer for the 0-to-100 kHz frequency range. It has 10 Hz bandwidth resolution. The 5CT1N is a semiconductor curve-tracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the CRT. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of either the 5100 or the 5400 Series to 1 GHz at 2 mV sensitivity.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and the recommended X1 and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the CRT when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.

CARTS

SCOPE-MOBILE® Carts — For cabinet models, order TEK Lab Cart, Model 3; for rackmount models, order TEK Rack Cart, Model 7.

CAMERAS

All 5100 Series — C-5C, suitable for repetitive or stored traces.

5100 Storage Instruments, 5440 (with P or R back), 5441 (with G back) — C-59, general purpose.

For full details see Camera section, page 262.

ACCESSORIES

Blank Plug-in Kit — (040-0818-03)

Blank Panel — (016-0195-02)

Viewing Hoods — (016-0154-00, or 016-0452-00 folding)

Protective Cover — (016-0544-00)

For full details see Accessories section, page 294-295.

5000 Series Instruments—Physical Characteristics

	5223				5100 and 5400 Series				Plug-ins			
	Cabinet		Rackmount		Cabinet		Rackmount		Single Width		Double Width	
Dimensions	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
Height	12.9	32.8	7	17.8	11.9	30.2	5.3	13.3	5.0	12.7	5.0	12.7
Width	8.4	21.4	19	48.3	8.4	21.3	19.0	48.3	2.6	6.6	5.2	13.2
Length	22.5	57.2	22.4	56.9	20.4	51.8	19.0	48.3	12.0	30.5	12.0	30.5
Weight (approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	37.25	16.9	42	19.1	23.0*	10.4*	24.0*	10.9*	2.8	1.3	5.8	2.6
Shipping	45	20.5	52	23.6	32.0*	14.5*	43.0*	19.5*	10.0	4.5	10.8	4.9

Rear Panel Signal Outputs, an optional feature for all 5100 Series Mainframes. See page 143.

*Add 2 lbs. (0.9 kg) net and shipping weights for 5400 Series.

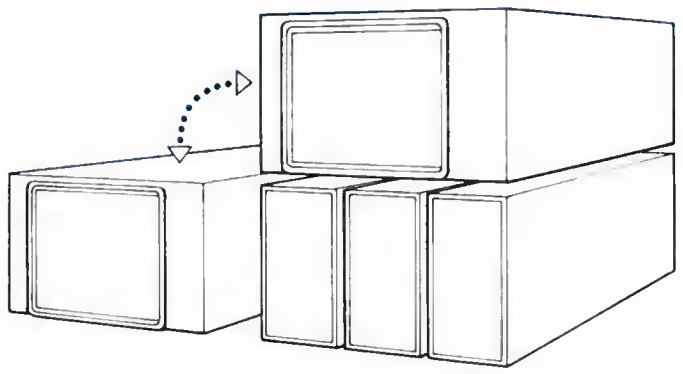
Recommended Probes for 5000 Series Amplifier Plug-ins

The following probes are recommended for general use with the listed amplifier plug-ins. These probes automatically program the knob-skirt readout and the crt readout (available only in the 5400 Series) to indicate correct deflection factor. Probe packages include various tips, ground leads and accessories.

Probes are also available in different lengths, attenuation ratios, input loading and bandwidths. Special purpose probes, such as high voltage, FET and current probes are avalable for use with 5000 Series Amplifier Plug-ins. See probe section for complete information.

Amplifier Plug-ins	Voltage Probe	Attenuation	Standard Length	Features	Package Number
5A14N 5A15N 5A18N	P6060	10X	6 ft	Full bw, low cost, (not compatible with CRT readout).	010-6060-03
	P6062B	1X/10X	6 ft	Full bw, switchable attenuation, ground reference button.	010-6062-13
5A13N 5A21N* 5A22N 5A26	P6062B	1X/10X	6 ft	Full bw, switchable attenuation, ground reference button.	010-6062-13
	P6101	1X	2 m	Full bw, miniature. Modular construction simplifies repair.	010-6101-03
	P6055	Adjustable to 10X	3.5 ft	Adjustable attenuation. Will give up to 20,000; 1 CMRR when used in pairs. (5A21N, 5A22N and 5A26).	010-6055-01
5A38	P6105	10X	2 m	Full bw, miniature. Modular construction simplifies repair.	010-6105-03
5A48	P6062B	1X/10X	6 ft	Switchable attenuation (full bandwidth in the 10X position) ground reference button.	010-6062-13
	P6101	1X	2 m	Miniature, modular (reduced bandwidth).	010-6101-03

The 5A21N also provides direct access to current probe P6021. Order 5A21N, Option 01 for 5A21N Amplifier and Current Probe package. See pages 145-146 for complete information.

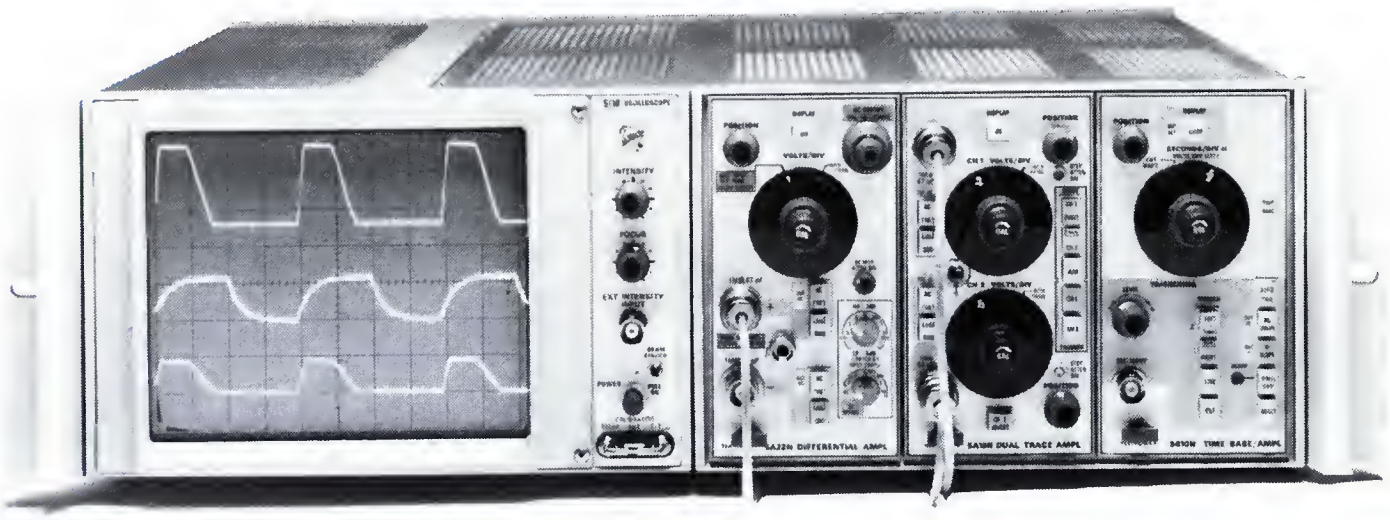


All 5000 Series Rackmount Oscilloscopes and cabinet-to-rackmount kits include complete slide out tracks and mounting hardware to interface with standard 19 inch racks.

CONVERSION KITS

Cabinet-to-Rackmount, Order 040-0583-02 .....$125
Rackmount-to-Cabinet, Order 040-0584-03 .....$125

CONVERTIBILITY: Cabinet-to-Rackmount, Rackmount-to-Cabinet



Mechanical Measurement Transducers

TRANSDUCER PACKAGE	DESCRIPTION	PERFORMANCE	RECOMMENDED ACCESSORIES
PRESSURE 015-0161-00*	RANGE: 3000 psig TYPE: Bonded Strain Gage 4 erm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitetion: ≃10 Vdc Scale Factor. 3 mV/V f.s. f_n ≃65 kHz	012-0209-00 20 ft multi- conductor cable
PRESSURE 015-0162-00*	RANGE: 300 psig TYPE: Bonded Strain Gage 4 arm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitetion: ≃10 Vdc Scale Factor: 3 mV/V f.s. f_n ≃24 kHz	012-0209-00 20 ft multi- conductor cable
PRESSURE (EAS) 015-0117-00	RANGE: 3000 psig (dynamic only) TYPE: Piezoelectric	Accuracy: <5% Sensitivity: 200 pc/psi Max Overpressure: 300% Temp: −40°C to +150°C max	015-0118-00 cooling adapter
ACCELERATION 015-0165-00	RANGE: 0.001 to 1000 g's TYPE: Piezoelectric compression High capacitance (≃ 10,000 pF) NBS traceability	Accuracy: 5% Linearity: 2% Sensitivity: ≃12 mV/g f_n ≃30 kHz	012-0211-00 microdot to BNC 20 ft cable
VIBRATION (EAS) 015-0116-00	RANGE: 0.01 to 100 g's (100 to 10,000 RPM) TYPE: Piezoelectric magnetically mounted	Sensitivity: 6 mV/g (o.c.) C_T ≃3500 pF Temp: −40°C to +150°C f_n ≃11 kHz	012-0137-00 BNC-BNC cable 50 ft
VERTICAL VIBRATION 015-0166-00 HORIZONTAL VIBRATION 015-0167-00	TYPE: Seismic (geophone) Self generating SIGNALS: Velocity Displacement (integrated velocity) RANGE: 0.050 inch peak to peak	Accuracy: <5% Scale Factor: Velocity ≃ 600 mV/in/s Displacement ≃ 10 mV/0.002 in Freq Range: 10 Hz to 2 kHz f_n ≃ 8 Hz Temp: −40°C to +71°C	012-0136-00 BNC-BNC cable 20 ft long
FORCE (Displacement) 015-0164-00*	RANGE: 50 grams 50 lbs (with load cell) 0.120 mm TYPE: Unbonded 350 Ω Strain Gage 4 erm bridge	Accuracy: 0.5% Excitation: ≃5 Vdc Full Scale Output: 60 to 80 mV Temp: −50°C to +85°C	Included with unit is 50 lb (22-5 kg) load cell connected power cable ettach- ment bracket and tools
DISPLACEMENT 015-0168-00	RANGE: ±4.0 mm (Calibrated and usable to ±0.2 inch) TYPE: Dc to dc LVDT	Accuracy: 2% linearity <1% Excitation: 3 to 11 Vdc Scale Factor: 1 V/mm at 8.5 Vdc 20 mV/0.001 inch at 7.5 Vdc Temp: −54°C to +60°C	012-0209-00 20 ft cable
STRAIN 015-0171-00	RANGE: 30,000 μ Strain TYPE: Foil Strain Gages 0.125 inch long. Attached leads. Package of five	Resistance: 120 Ω Gege Factor (Nominel) 2.1 Accuracy: 1% Excitation: (bridge). 5 V max	Strain Gage Adapter, 015-0169-00 Cement Kit 015-0172-00
STRAIN GAGE ADAPTOR 015-0169-00*	Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type PS 501-1 Mod 730E Transducer Power Supply. Has variable shunt resistor for gage factor calibretion. The adapter has four binding post terminals end a six-foot cable with 6-pin connector.	Accurecy: Governed by initial calibration end strain gages used. Strain Gage Resistance Rangc: 30 Ω to 5000 Ω for 4 arm bridges. 120 Ω for 1, 2 or 4 erm bridges. Bridge Volts: Typlcally 5 V for 120 Ω geges. Gage Factor Correction Range: 1.7 to 2.3	Strein Gage Package. 015-0171-00 Cemont Kit, 015-0172-00
CEMENT KIT 015-0172-00	Provides means for mounting and connecting foil strain gages. Includes Room Temperature Curing Epoxy cement, RTV Clear Silicon Rubber coating, Neoprene pads end metal plates, cementable Wiring terminels, and clear Mylar fiim.		Strain Gage Package, 015-0171-00

CABLE (012-0136-00) $34
20 ft low-noise coaxlal cable with BNC connectors on both ends.

CABLE (012-0209-00) $315
20 ft low-noiaa six-conductor cable with 6-pin connector on each end.

CABLE (012-0210-00) $90
20 ft six-conductor cable with 6-pin male connector on one end.

CABLE (012-0211-00) $30
20 ft low-noise coaxial cable with miniature coaxial connector on one end and BNC connector on the other.

CONNECTOR (131-0618-00) $25
Mates Type PS501-1 Transducer Power Supply INPUT 6-pin connector.

TRANSDUCER PACKAGE PRICE LIST

015-0161-00	$500	015-0167-00	$225
015-0162-00	$575	015-0164-00	$625
015-0117-00	$900	015-0168-00	$360
015-0165-00	$390	015-0171-00	$35
015-0116-00	$600	015-0169-00	$235
015-0166-00	$165	015-0172-00	$50

*Requires PS 501-1 custom modified Transducer Power Supply mounted in e TM 500 Series Mainfreme. Consult e Tektronix Sales Engineer for price and installation informetion on power supply and adapter.

APPLICATION NOTES

Following is a list of currently available Application Notes for 5000 Series Oscilloscopes.

Title Featuring	Part No.
STRUCTURAL TESTING The Digitizing Approach 5223/5B25N/5A18N Single-shot techniques. Multi-trace using transducers.	AX-4461
BIOPHYSICAL DATA RETRIEVAL The Digitizing Approach 5223/5B25N/5A18N Roll mode, chart recorder output.	AX-4462
RECORDING ELECTRO-PHYSIOLOGICAL NERVE ACTIVITY Using a plug-in oscilloscope 5113/5A26/5A22N Low level measurements and storage.	AX-3746
INTERPRETING MECHANICAL MEASUREMENTS With the plug-in oscilloscope 5111/5A22N/5A18N Transducer measurements and storage.	AX-3533
SIMULTANEOUS DISPLAY Of two independent X-Y signal pairs 5111/5A15N/5A15N/5A18N. Dual X-Y techniques, engine analysis.	AX-4114
SIMULTANEOUS X-Y, Y-T DISPLAYS 5111/5A15N/5A15N/5B12N. X-Y, Y-T techniques. Bio-medical application.	AX-4113
CUSTOM PLUG-IN IDEAS For 5000 Series scopes Recommended starter note for customers considering custom plug-in project.	AX-3758
A HIGH RESOLUTION 60 Hz notch filter Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum.	AX-4031
A TRUE RMS CONVERTER Construction project using thermal true RMS converter module in our blank plug-in kit. Measures true RMS up to 200V RMS.	AX-4112

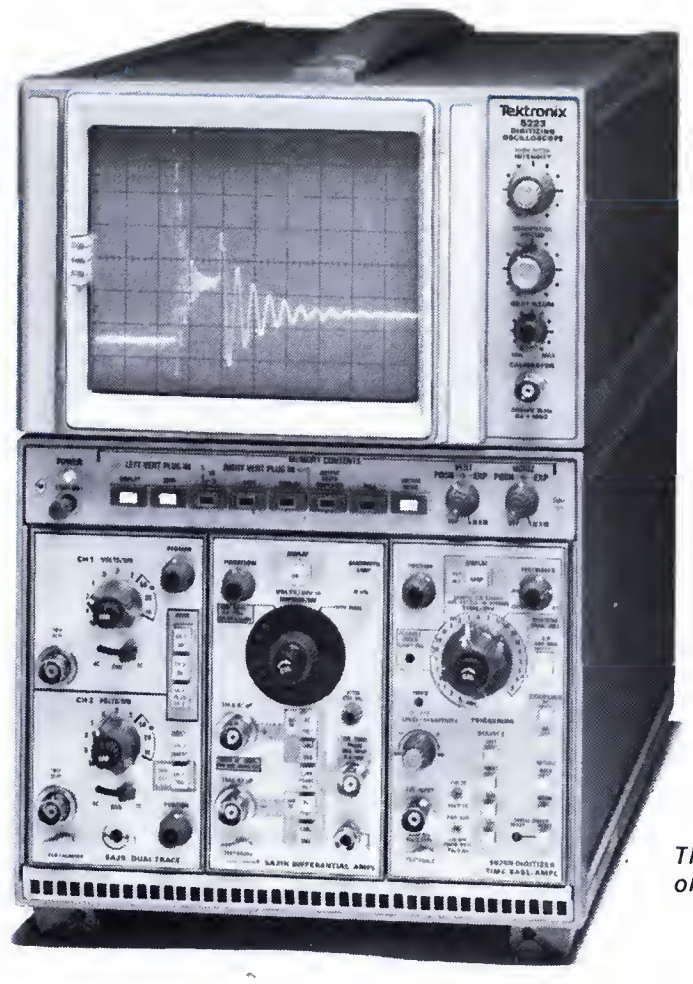
10 MHz Digital Storage Oscilloscope

NEW 5223

- Digital Storage (with 5B25N)
- 10 MHz Bandwidth Repetitive Store
- 100 kHz Bandwidth Single Shot Store
- Pre-trigger
- 10 Bit Vertical Resolution
- Stored X versus Y Display
- Roll Mode
- X-Y Plotter Output with Penlift

GPIB Product

The 5223 is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk, Listen.



The digital storage functions can only be accessed or enabled by using the 5B25N time base.

The TEKTRONIX 5223 Digitizing Oscilloscope is a digital storage instrument with a real-time bandwidth of 10 MHz. The 5223 is capable of displaying real-time and stored waveforms simultaneously (four real-time waveforms and four stored waveforms, if dual channel amplifier units are used); the real-time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of 10, using front-panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front-panel display function. The roll mode is useful when viewing low-frequency signals. Rear-panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000 Series Plug-in units; the flexibility of the plug-in feature, and variety of plug-in units available, allows the system to be used for many measurement applications.

DISPLAY and SAVE functions

The DISPLAY buttons allow the 5223 to digitize the signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs, or until the SAVE button is pushed. The SAVE buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

L vs R display

This function will display the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right compartment defines the horizontal axis. Since the X-Y display is from memory, the real-time sweep is still in the standard Y-time format and may be displayed simultaneously.

ROLL display

For continuous data stream monitoring of biomedical or low frequency events, Roll Mode digitizes the signal and displays the latest acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip chart recorder. Available on the sweep range of 5 sec/div to 0.1 sec/div.

VECTOR display

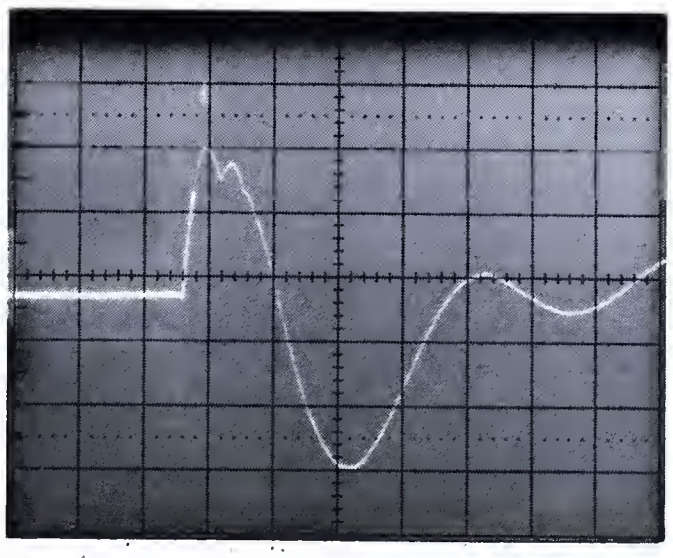
When selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data to reduce interpretation errors.

OUTPUT SAVED displays

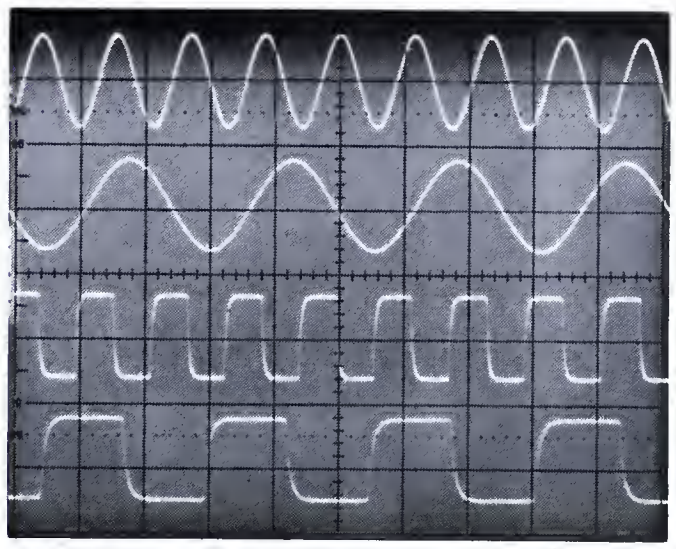
When pressed, an analog output of the displayed saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

DISPLAY OUT SPEED control (rear panel)

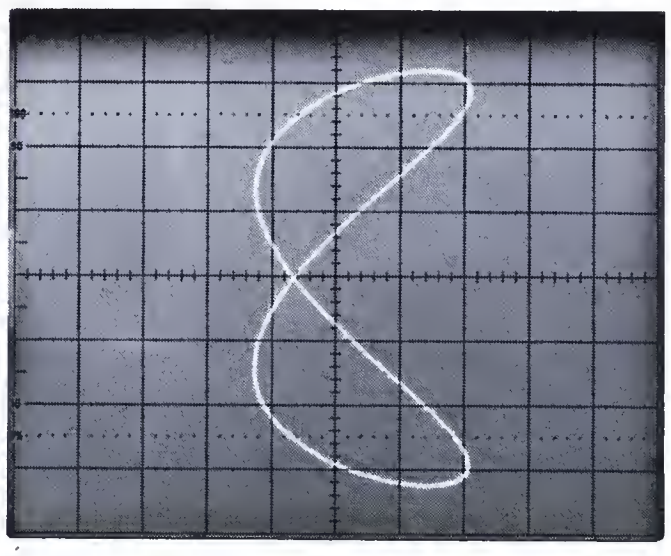
This controls the X-Y plotter output speed to adjust for differences in plotter speeds and response.



Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.



Up to four channels may be stored at a time either Single Shot or Repetitive.



By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.

VERTICAL REAL TIME SYSTEM

Channels — Two plug-in compartments; compatible with 5000 Series Plug-ins.

Mainframe Bandwidth — 10 MHz with 5A38, 5A45 or 5A48.

Mainframe Step Response — 35 ns.

Chop Mode — 100 chopped segments/division unexpanded with 5B25N Time Base.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL REAL TIME SYSTEM

Channel — Single compartment compatible with 5000 Series time bases and amplifiers. 5B25N must be used in storage modes.

Fastest Calibrated Sweep Rate — 20 ns/div.

X-Y Mode — Less than 2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

DIGITAL STORAGE (with 5B25N)

Vertical Resolution — 10 bits (100 pts/div unexpanded).

Display Memory Size — 1K points per vertical compartment, shared by multiple trace plug-ins.

Sample Rate — Maximum of 1 μs/pt (1 MS/s). Actual sample rate depends on time base setting.

Fastest Single Shot Sweep Speed — 100 μs/div.

External Clock In — Maximum of 1 MS/s (1 μs/pt). TTL compatible.

Equivalent Time Bandwidth — 10 MHz.

Acquisition Window — ±4 divisions vertically and ±5 divisions horizontally from center screen.

Accuracy — Determined by plug-ins. Refer to plug-in specifications.

X-Y — (left vs right single channel mode only excluding 100 μs/division sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400 Series vertical plug-ins.

MEMORY CONTROLS

Display and Save — Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector Mode, Horizontal and Vertical positioning, and expansion (≥10:1).

Data Out — Analog voltage of stored signal. 200 mV/div ±5%. Output rate variable with rear panel control. Pen lift available on rear panel (normally open).

OUTPUT/INPUTS

Plug-in Signal Outputs:

Left vertical, right vertical, horizontal compartments —50 mV/division ±5% from 50 Ω.

Left, right vertical compartments—dc ≥10 MHz; horizontal compartment—dc ≥7 MHz.

Time base gate—TTL compatible, positive going.

Remote Single Sweep Reset — Rear panel BNC closure to ground resets sweep.

External Z Axis Input — Usable, dc ≥5 MHz Voltage swing of 5 volts will fully modulate beam dc ≥1 MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).

Calibrator:

Voltage Output—Square wave, positive going from ground. Amplitude is 300 mV ±1%.

Current Output—3 mA ±1% available through calibrator output with optional BNC to current loop adapter.

CRT AND DISPLAY FEATURES

CRT — 8 x 10 divisions with 1.22 cm/div. Internal illuminated graticule.

Phosphor — P31.

Acceleration Potential — 15 kV.

Camera Power — Compatible with C-59 Tektronix camera.

POWER REQUIREMENTS

Line Voltage Range — 90-117 V, 102-132 V, 191-249 V, 204-250 V max.

Line Frequency — 48-62 Hz (48-440 Hz, Option 05).

Max Power Consumption — 145 W at 120 V, 60 Hz.

OPTIONS

Option 05 Line Frequency Change (48-440 Hz) — Converts the R5223 to 48-440 Hz operation.

Option 10 GPIB Interface — For I/O of stored waveforms and control of 5223 digital storage functions (except vert and horiz expansion and position controls). Waveform Output format is selectable through the interface for either BINARY or ASCII.

I/O Records — Waveforms.

Device Address — Selectable via rear panel switch.

Talk/Listen — Full bi-direction transfer of waveforms plus remote manipulation of storage controls.

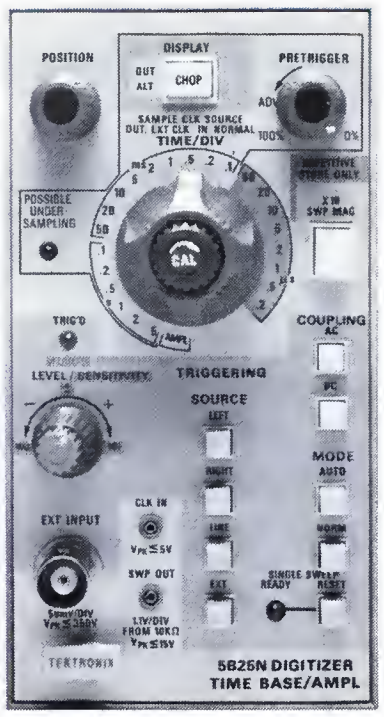
Talk Only — Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

Implemented Interface Functions:

SH1	Complete Source Handshake
AH1	Complete Acceptor Handshake
T5	Talker Function
L4	Listener Function
SR1	Complete Service Request Capability
RL2	Remote/Local Capability
DC1	Complete Device Clear Capability

PLUG-IN COMPATIBILITY

All 5000 Series Plug-ins are compatible in the standard oscilloscope display mode. The 5L4N, 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital storage operation. The 5A14N is not recommended for use in storage mode.



5B25N

5B25N Time Base

The 5B25N is required with the 5223 to enable the digital functions and waveform acquisition. The 5B25N combines the performance of a standard 5B40 time base for real time displays and a crystal controlled clock to drive the digitizer. Additional features of the 5B25N aid in the triggering and acquisition signals to be stored.

Pre-Trigger

For viewing events which occur prior to the trigger, a PRETRIGGER control is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pre-trigger selected. This intensified zone remains with the saved waveform. Pre-trigger is available from 5 sec/div to 0.1 ms/div.

Possible Undersampling Indicator

To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.

Bi-Slope Triggering

Besides the standard positive and negative slope and level control, the 5B25N has Bi-Slope triggering. When selected, Bi-Slope will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope to select, for example, in collision and destructive testing where a wrong guess could be costly.

Sampling Rate

For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.

Repetitive Store

For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50 μs/div to 0.2 μs/div.

External Clock Input

Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

DIGITIZER-RELATED FUNCTIONS
(5223 Mainframe Only)

Overall Speed Accuracy Of Digitized Signal— (Center 8 Div). Excluded portions first 200 ns or 0.2 div of each waveform	Digitized Waveform	Digitized Waveform Relative To Real-Time Waveform	
		CAL	UNCAL
2 and 5 s/div	3%	4%	6%
1 s-0.1 ms/div	3%	3%	5%
50 μs-0.2 μs/div	3%	3%	3%

See page 141 for details.

ORDERING INFORMATION

5223 Digitizing Oscilloscope **$4995**
R5223 Rackmount **$5145**

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 Universal Euro 220V/16A ..... **No Charge**
Option A2 UK 240 V/13A ..... **No Charge**
Option A3 Australian 240 V/10A ..... **No Charge**
Option A4 North American 240 V/15A ..... **No Charge**

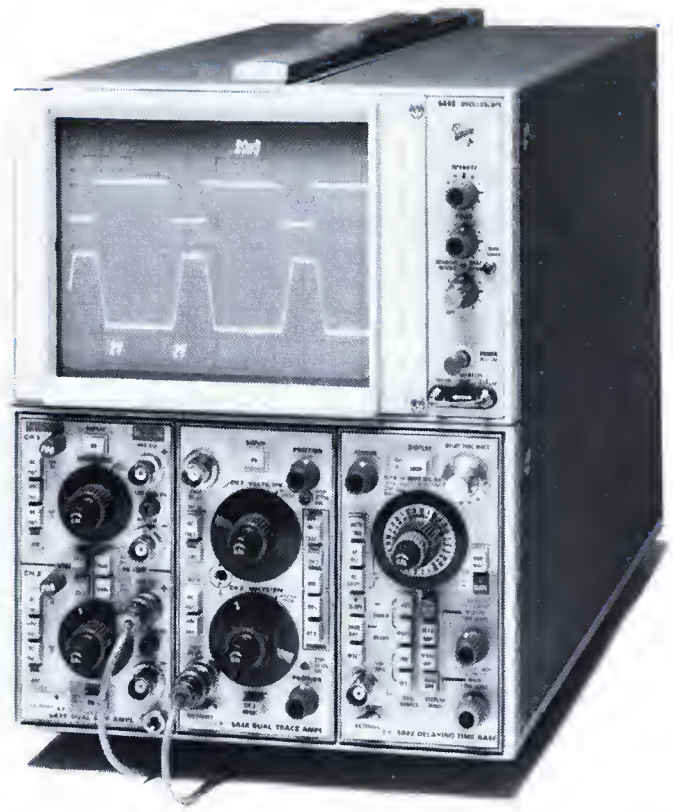
Option 05 Line Freq change (R5223 only) ... **Add $200**
Option 10 GPIB Interface ..... **Add $1000**

5B25N Time Base **$775**

50 MHz General Purpose Oscilloscope

5440/R5440

- Low Cost
- Dc to 50 MHz
- Sampling to 1 GHz
- CRT Readout
- 3 Plug-in Flexibility
- Choice of 19 Plug-ins
- Bench to Rack Convertibility



The 5440 combines versatility and low cost in a 50 MHz general-purpose, plug-in oscilloscope. It features CRT readout of plug-in scale factors, a 3 plug-in mainframe, a choice of 19 plug-ins* and bench to rack convertibility.

CRT readout displays plug-in scale factors on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. It can also be accessed externally. This unique ability can be used to read out dates, picture numbers, digital clock times, etc.

All the plug-ins in the 5000 Series are compatible with the 5440.**

The wide variety of plug-ins available lets you configure your oscilloscope to meet your needs today as well as tomorrow: from a single-trace, single time-base configuration for production monitoring, to 4-trace, delayed sweep for logic work, to 4-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

If you're looking for a general-purpose oscilloscope, the 5440 gives you the most versatility and performance at the lowest price.

Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout.

***The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

VERTICAL SYSTEM

Channels — Left and center plug-in compartments are compatible with all 5000 Series Plug-ins. CRT readout is not available with plug-ins having a suffix N (5B10N, etc.).

Deflection Factor — Determined by plug-in unit.

Bandwidth — 50 MHz, determined by plug-in unit.

Chopped Mode — The 5440 will chop between channels at approx 25 to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode — Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5440 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5000 Series Plug-ins. CRT readout is not available for plug-ins with a Suffix N.

Internal Trigger Mode — Left vertical, center vertical.

Fastest Calibrated Sweep Rate — 10 ns/div, determined by plug-in.

X-Y Mode — Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

CRT — Internal parallax-free 8 x 10 div (1.22 cm/div) graticule with edge-lit illumination.

Phosphor — P31 Standard, P7 or P11 optional.

Accelerating Potential — 15 kV.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 2 MHz. Input R and C is approx 10 kΩ paralleled by approx 40 pF. Max input is ±50 V (dc + peak ac).

OTHER CHARACTERISTICS

Calibrator — Voltage amplitude is 400 mV within 1%. Current is 4 mA within 1%. Frequency is 2 times the line frequency.

Minimum Photographic Writing Speed — Using Polaroid film without film fogging. Writing speed can be increased with the TEKTRONIX Writing Speed Enhancer (see Camera section for more information).

Writing Speed cm/μs				Camera	Lens
P31 Phosphor		P11 Phosphor			
10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
180	90	245	125	C-59R	f/2.8 0.67 mag
330	160	450	230	* ** C-50R	f/1.9 0.7 mag

**Slight cropping of the graticule corners.*

***Requires optional battery pack (016-0270-01) for operation with the 5440.*

Beam Finder — Intensifies trace and brings it into graticule areas.

Ambient Temperature — Performance characteristics valid from 0°C to +50° unless otherwise specified.

Line Voltage Range — 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that max input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Max Power Consumption — 100 W at 120 V ac, 60 Hz.

OPTIONS

Option 01 without CRT Readout — The 5440 may be ordered without CRT readout. This feature can easily be added later with a conversion kit.

Option 03 User Addressable CRT Readout — An additional CRT readout access is available for the operator to program two 10-digit characters such as time, operator name, or test number. The additional display is useful for photographic records and is programmed by external resistors and switches.

Option 04 Protective Panel Cover (Cabinet Model Only) — The 5440 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

For Recommended Cameras — See Camera section, page 262.

ORDERING INFORMATION

(Plug-ins not included)

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 5.25 in. rackmount oscilloscope with slide-out assembly.

5440 Oscilloscope **$2090**

R5440 Oscilloscope (Rackmount) **$2140**

OPTIONS

Option 01 without CRT Readout ..... **Sub $300**
Option 03 User Addressable CRT Readout .... **Add $75**
Option 04 Protective Panel Cover (Cabinet Model Only) ..... **Add $25**
Option 76 P7 Phosphor **$35**
Option 78 P11 Phosphor **$35**

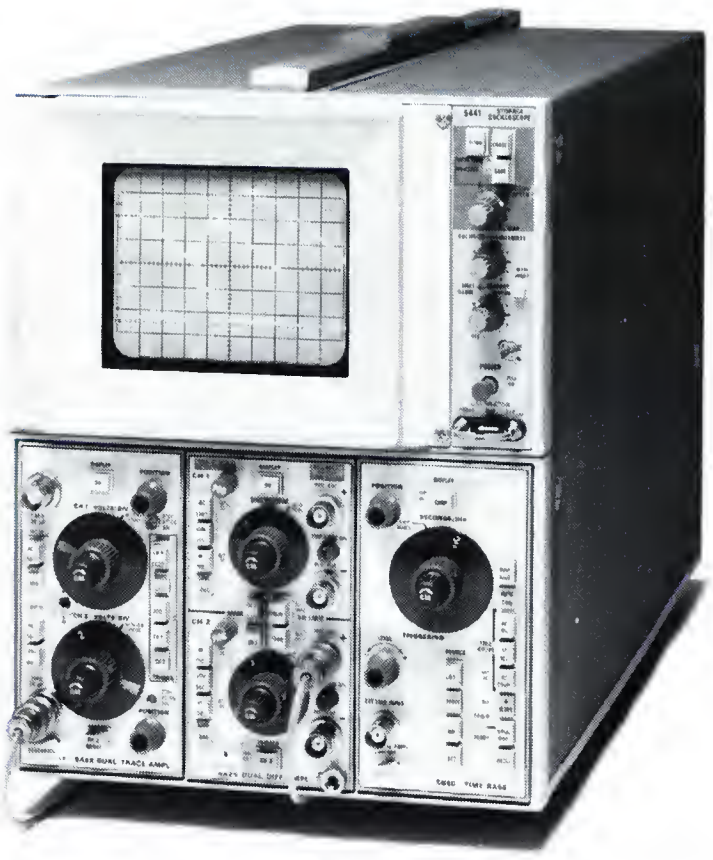
Conversion Kits

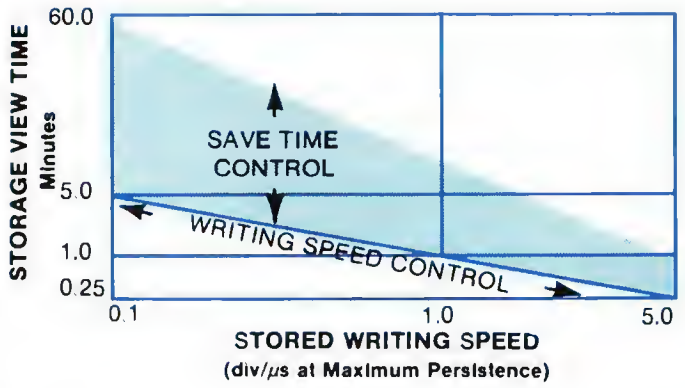
Cabinet-to-Rackmount, Order 040-0583-02 ..... **$125**
Rackmount-to-Cabinet, Order 040-0584-03 ..... **$125**
CRT Readout, Order 040-0691-01 ..... **$450**

50 MHz Variable Persistence Storage Oscilloscope

5441/R5441

- Low Cost
- Variable Persistence Storage
- CRT Readout
- Dc to 50 MHz
- 3 Plug-in Flexibility
- 19 Versatile Plug-ins
- Bench to Rack Convertibility
- 5 div/μs Stored Writing Speed





With the 5441 Variable Persistence Storage Oscilloscope, view time at normal intensity can be varied from a fraction of a second to more than 5 minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

High-speed events that occur only once or at very low repetition rates are easily observed. You can make low frequency measurements more easily and accurately by eliminating flicker or transforming a slowly moving dot into a stable display. Repetitions of the same signal can be compared simultaneously to detect changes in amplitude or phase. The integrating effect of variable persistence can be used to suppress the random noise that obscures low signal-to-noise ratio waveforms.

The 5441 enhances the capabilities of the 5000 Series Sampler and Spectrum Analyzer Plug-ins. In sampling applications, discrete dot traces are converted into a continuous waveform by holding repeated sweeps on the CRT.

In spectrum analysis, slow scan rates are used to maximize resolution. With the 5441, it is easy to display a full-scan pattern simultaneously even when the scan rate yields full-scale periods of more than a second.

Like other 5400 Series Oscilloscopes, the 5441 offers CRT readout of deflection factors for convenient, error-free measurements and optional user-programmable CRT readout of test information for ready identification and easy photographic recording. and a choice of 19 plug-ins, you can make With the flexibility of a 3 plug-in mainframe virtually any measurement from dc to 50 MHz.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5000 Series Plug-ins. CRT readout not available for plug-ins with suffix N.

Deflection Factor—Determined by plug-in.

Bandwidth—50 MHz, determined by plug-in.

Chopped Mode—The 5441 will chop between channels at approx 25 kHz to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode—Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5441 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5000 Series Plug-ins. CRT readoul not available for plug-ins with suffix N.

Internal Trigger Mode—Left vertical, right vertical.

Fastest Calibrated Sweep Rate — 10 ns/div, determined by plug-in.

X-Y Mode—Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

CRT—Internal, parallax-free, 8 x 10 div (0.9 cm/div) graticule with edge-lit illumination.

Persistence—Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

Phosphor—P31.

Accelerating Potential— 8.5 kV.

Max Stored Writing Speed—Writing speed greater Ihan 5 div/μs for a view time of 15 s.

Storage View Time — The view time is the amount of time the stored signal can be viewed before it fades away.
At the max writing speed the view time is 15 seconds or 0.25 minutes with the writing speed control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart next column).

Save Mode—Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.

Erase Time — 0.5 s ±10%.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Dc to 2 MHz usable frequency range. Input R and C approx 10 kΩ paralleled by approx 40 pF. Max input 50 V (dc + peak ac).

OTHER CHARACTERISTICS

Beam Finder—Intensifies trace and brings it into graticule area.

Auto Focus—Reduces the need for manual focusing with changes in intensity after the front-panel FOCUS control has been set.

Calibrator—Voltage amplitude 400 mV ±1%. **Current** amplitude 4 mA ±1%. Frequency is 2 times line frequency.

Ambient Temperature—Performance characteristics valid from 0°C to +50°C unless otherwise specified.

Line Voltage Ranges— 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that max input should not exceed 250 V ac.) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Max Power Consumption—100 W at 120 V ac, 60 Hz.

OPTIONS

Option 01 without CRT Readout—The 5441 may be ordered without CRT readout. This feature can easily be added later with a conversion kit.

Option 03 User Addressable CRT Readout—CRT readout access allows the operator to program up to two 10-digit words.

Option 04 Protective Panel Cover (Cabinet Model Only)—The 5441 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

Option 05—A 1 div/μs writing speed can be ordered (at a significantly lower price) when a writing speed of 5 div/μs is not required.

For Recommended Cameras — See Camera section, page 262.

ORDERING INFORMATION

(Plug-ins not Included)

5441 Oscilloscope **$3605**
R5441 Oscilloscope (Rackmount) **$3655**

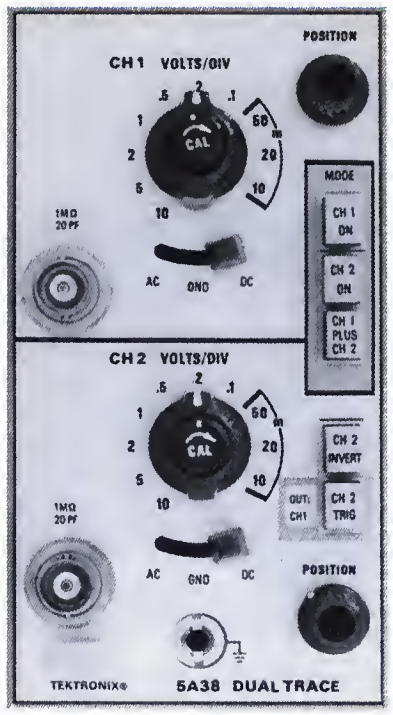
OPTIONS

Option 01 without CRT Readout ..... **Sub $300**
Option 03 User Addressable CRT Readout .... **Add $75**
Option 04 Protective Panel Cover (Cabinet Model Only) ..... **Add $25**
Option 05 Reduce Writing Speed to 1 div/μs ..... **Sub $300**

CONVERSION KITS

Cabinet-to-Rackmount, Order 040-0583-02 ..... **$125**
Rackmount-to-Cabinet, Order 040-0584-03 ..... **$125**
CRT Readout, Order 040-0691-01 ..... **$450**

Dual Trace Amplifiers and Time Base



5A38

Dc to 35 MHz

5A38 Dual-trace Amplifier

Low Cost

Dc to 35 MHz Bandwidth

10 mV/div to 10 V/div Calibrated Deflection Factors

The 5A38 is a dual-trace, 35 MHz plug-in amplifier for use only in the 5223 and the 5400 Series Mainframes. It features 10 mV/div sensitivity and CRT readout of deflection factor.*

Bandwidth—Dc coupled, to ≥35 MHz. Lower end response, ac coupled, ≤ 10 Hz.

Display Modes—Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from channel 1 or channel 2.

Rise Time— ≤10 ns.

Deflection Factors—Calibrated deflection factors from 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤ 3% from 15°C to 35°C, 4% from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

Common-Mode Rejection Ratio— ≥50:1 up to 1 MHz.

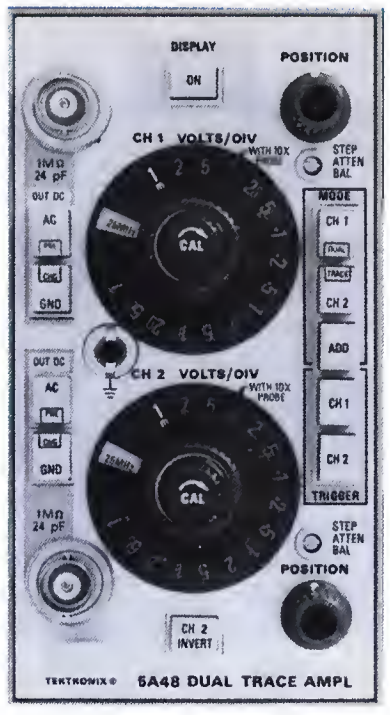
Channel Isolation— ≥50:1 to 35 MHz with both traces displayed.

Input R and C— 1 MΩ shunted by approx 20 pF.

Max Input Voltage—Dc coupled, 250 V (dc ÷ peak ac); ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max at 1 kHz or less.

Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

*CRT readout not functional in 5223.



5A48

Dc to 50 MHz

5A48 Dual-trace Amplifier

Dc to 50 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A48 is a dual-trace 50 MHz plug-in amplifier for use only in the 5223 and the 5400 Series Mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.*

Bandwidth—Dc coupled, dc to at least 50 MHz at 5 mV/div to 10 V/div, decreasing to dc to 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac coupled, 10 Hz or less (1.0 Hz with a 10X probe) at all deflection factors (3 dB down).

Display Modes— Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, Added, Alternated, Chopped (determined by time-base plug-in horizontal compartment). Internal trigger source is selectable from Channel 1 or Channel 2.

Rise Time—7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

Deflection Factors — Calibrated deflection factors from 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤5% at 1 mV/div and 2 mV/div, ≤3% from 5 mV/div to 10 V/div from 15°C to 35°C, ≤4% from 5 mV/div to 10 V/div from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

Common-Mode Rejection Ratio—≥50:1 from 5 mV/div to 10 V/div, up to 1 MHz. ≥ 20:1 from 1 mV/div to 2 mV/div, up to 1 MHz.

Input R & C— 1 MΩ within 1%, approx 24 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac; ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 1 kHz or less.

Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

*CRT readout not functional in 5223.

5B40

Time Base

5B40 Time Base

Low Cost

10 ns/div to 5 s/div Calibrated Time Base

Triggering to 50 MHz

The 5B40 Time Base is designed for use only in 5400 Series Mainframes. It features sweep rates from 10 ns/div to 5 s/div and CRT readout of the sweep rate selected.

Sweep Rate — 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Sweep Accuracy — Measured in 5400 Series Oscilloscope over center 8 graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%

TRIGGERING

Coupling	Frequency Range	Minimum Signal Required	
		Int	Ext
Dc	Dc to 10 MHz 10 MHz to 60 MHz	0.4 div 1.0 div	60 mV 150 mV
Ac	Trigger requirements increase below 50 Hz.		
Lf Rej	Trigger requirements increase below 7.5 kHz.		
Hf Rej	Trigger requirements increase above 50 kHz.		

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

External Trigger Input — Max input voltage is 350 V dc + peak ac, 350 V p-p ac at ≤1 kHz. Input R and C is 1 MΩ paralleled by approx 24 pF. Trigger level range is ≥ ± 1.5 V.

External Horizontal Input — Deflection factor is 50 mV/div ±3%. Input R and C is 1 MΩ paralleled by approx 24 pF. Dc coupled bandwidth is dc to ≤2 MHz. The ac coupled lower response is ≤50 Hz. Max input voltage is 350 V (dc + peak ac) or 350 V p-p ac at ≤1 kHz.

For recommended probes — refer to page 134.

Time Bases

5B42 Delaying Time Base

10 ns/div to 5 s/div Calibrated Time Base
Single-Sweep Operation
Triggering to 50 MHz

The 5B42 Delaying Time Base is designed for use in 5400 Series Mainframes. The 5B42 is designed so that the user may easily operate the time base in the many applications where delayed sweep and sweep rates up to 10 ns/div are required.

The 5B42 also features CRT readout and an edge-lighted seconds/div selector switch.

Sweep Rate — 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy — Measured over the center 8 div. Same as 5B40. See chart in left column.

TRIGGERING

Coupling	Frequency Range	Minimum Signal Required	
		Int	Ext
Dc 5400 ampl	Dc to 10 MHz	0.4 div	100 mV
5400 ampl	10 MHz to 60 MHz	1.0 div	400 mV
5100 ampl	Dc to 2 MHz	0.4 div	100 mV
Ac	Requirements increase below 50 Hz.		
Ac Lf Rejection	Requirements increase below 7.5 kHz.		

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

External Trigger Input — Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, approx 20 pF. Trigger level range is at least ±2.5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Multiplier Range — 0.2 to 10 times the TIME/DIV setting.

Differential Time Measurement Accuracy — Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale for 1 s to 5 s delay time.

Jitter — Less than 0.05% of the time represented by one div of delaying sweep selected.

DELAYED SWEEP

Sweep Rate — 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.

Sweep Accuracy — Measured over the center 8 div. Same as undelayed sweep. See chart at left.

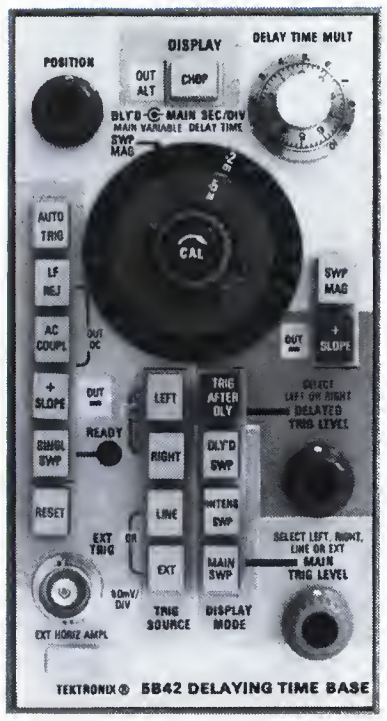
TRIGGERING

Coupling	Frequency Range	Min Signal Required
		Int
Dc 5400 ampl	Dc to 10 MHz	0.4 div
5400 ampl	10 MHz to 60 MHz	1.0 div
5100	Dc to 2 MHz	0.4 div

EXTERNAL HORIZONTAL INPUT

Deflection Factor — 50 mV/div within 3%.

Bandwidth — Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.



5B42

NEW

5B25N Digital Time Base

Bi-Slope Triggering
20 ns/div to 5 s/div Calibrated Time Base
Triggering to 15 MHz

The 5B25N is designed specifically for use in the 5223 Digital Storage Oscilloscope. PRE-TRIGGER is only available with the 5223 (see page 136). However, the standard analog sweep features including Bi-Slope Triggering and X10 MAG are compatible with 5400 series mainframes.

CHARACTERISTICS

BI-SLOPE TRIGGERING

Besides the standard positive and negative slope and level control, the 5B25N has Bi-Slope triggering. When selected, Bi-Slope will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope to select, for example, in collision and destructive testing where a wrong guess could be costly.

Modes — Auto, Normal, Single Sweep.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

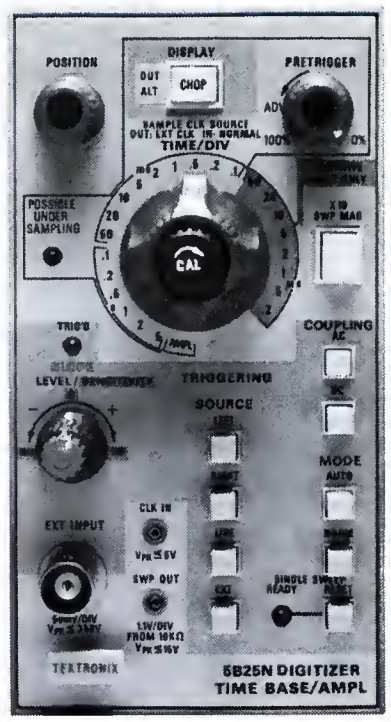
External Trigger Input — Max input voltage is 350 V-peak. Input R and C is 1 MΩ paralleled by approx 24 pF.

External Horizontal Input — Deflection factor is 50 mV/div ±3%. Dc coupled bandwidth is dc to 2 MHz.

Sweep Rate — 0.2 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Sweep Accuracy — Measured in 5400 Series Oscilloscope over center 8 graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.2 μs/div	3%	4%	4%	5%
5 s/div and 2 s/div	4%	5%	5%	6%



5B25N

TRIGGERING

Slope	Frequency Range	Minimum Signal Required	
		Int	Ext
+ or −	Dc to 1 MHz	0.4 div	50 mV
	1 MHz to 15 MHz	0.6 div	200 mV
± (Bi-Slope)	DC[1] to 1 MHz	±0.5 div	±50 mV

[1]30 Hz when ac coupled.

5B25N CHARACTERISTICS WHEN USED WITH THE 5223 MAINFRAME

PRE-TRIGGER

For viewing events which occur prior to the trigger, a PRETRIGGER control is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pre-trigger selected. This intensified zone remains with the saved waveform. Pre-trigger is available from 5 sec/div to 0.1 ms/div.

SAMPLING RATE

For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div (only when used with 5223).

REPETITIVE STORE

For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50 μs/div to 0.2 μs/div.

EXTERNAL CLOCK INPUT

Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

Digitizer-Related Functions (5223 Mainframe Only)

Overall Speed Accuracy Of Digitized Signal— (Center 8 Div). Excluded Portions: First 200 ns or 0.2 Div of Each Waveform	Digitized Waveform	Digitized Waveform Relative To Real-Time Waveform	
		CAL	UNCAL
2 and 5 s/div	3%	4%	6%
1 s - 0.1 ms/div	3%	3%	5%
50 μs - 0.2 μs/div	3%	3%	3%

ORDERING INFORMATION

5B25N Digital Time Base	$775
5B42 Delaying Time Base	$995
5A38 Dual-Trace Amplifier	$585
5B40 Time Base	$540
5A48 Dual-Trace Amplifier	$765

2 MHz Single-Beam, Dual-Beam and Storage Oscilloscopes

5100 Series Oscilloscopes

- Low Cost
- Dc to 2 MHz
- Sampling to 1 GHz
- Choice of 14 Plug-ins
- Rear Panel Signal Outputs Optional

COMMON CHARACTERISTICS
for 5110, 5111, 5113, 5115
unless otherwise specified

VERTICAL SYSTEM

Channels — Left and center plug-in compartments compatible with all 5100 Series Plug-ins.

Deflection Factor — Determined by plug-in.

Bandwidth — 2 MHz, determined by plug-in.

Chopped Mode — (5110, 5111, 5115) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≃5 μs, consisting of ≃3 μs displayed, ≃2 μs blanked. Chop or alternate mode is selected at the time base unit.

Chopped Mode — (5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≃5 μs, consisting of 3μs displayed, ≃2 μs blanked. Chop or alternate mode is selected at the time base unit.

Alternate Mode — (5110, 5111, 5115) Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

Alternate Mode — (5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5100 Series Plug-ins.

Fastest Calibrated Sweep Rate — 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode — Phase shift within 1° from dc to 100 kHz.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics valid from 0°C to +50°C.

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that max input should not exceed 250 V ac). Internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

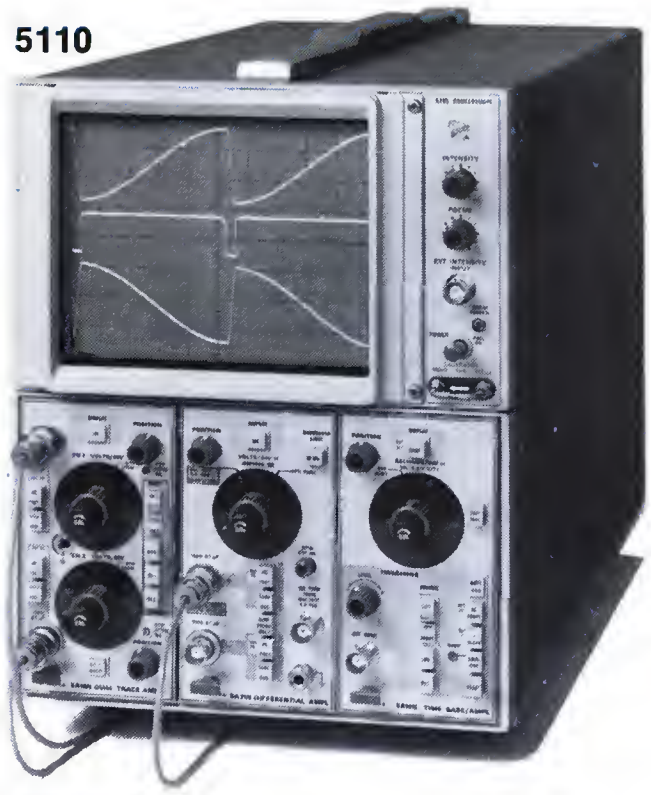
Typical Power Consumption — For 5110, 53 W. For 5111, 74 W. For 5113, 88 W. For 5115, 74 W.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is approx 10 kΩ paralleled by approx 40 pF. Max input ±50 V (dc + peak ac).

Calibrator — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

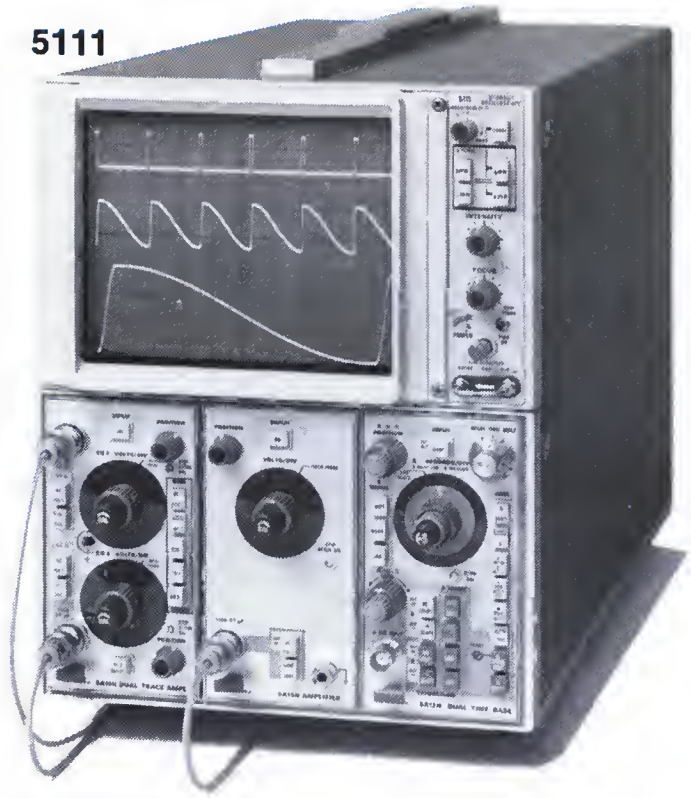
Beam Finder — Positions beam on screen regardless of vertical and horizontal position control settings.

5110



Single Beam

5111



Single-beam Storage

5110

- Lowest Cost Single-beam Nonstorage Oscilloscope with Plug-in Configurability
- 8 Channels at 1 mV/div, 4 Channels at 50 μV/div, 2 Channels at 10 μV/div, with Appropriate Amplifiers

The 5110 is a single-beam nonstorage oscilloscope featuring a large 6.5 in. diagonal (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four-channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from our extra low cost basic amplifier and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — P31 standard, P7 or P11 optional.

**Illuminated graticule available at extra cost.*

5111

- Single-beam Storage Oscilloscope
- Bistable, Split-screen Display
- Stored Writing Speed ≥20 div/ms
- Storage View Time up to 10 hrs at Reduced Intensity

The 5111 is a single-beam, split-screen, bistable storage oscilloscope with a large-screen, 6.5 in. diagonal (1.27 cm/div) display.

The 5111 extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography.

The 5111 is particularly useful for recording low and medium speed displays like those found in audio spectrum analysis, semiconductor curve tracing, sampling, vibration analysis, and the biophysical sciences.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

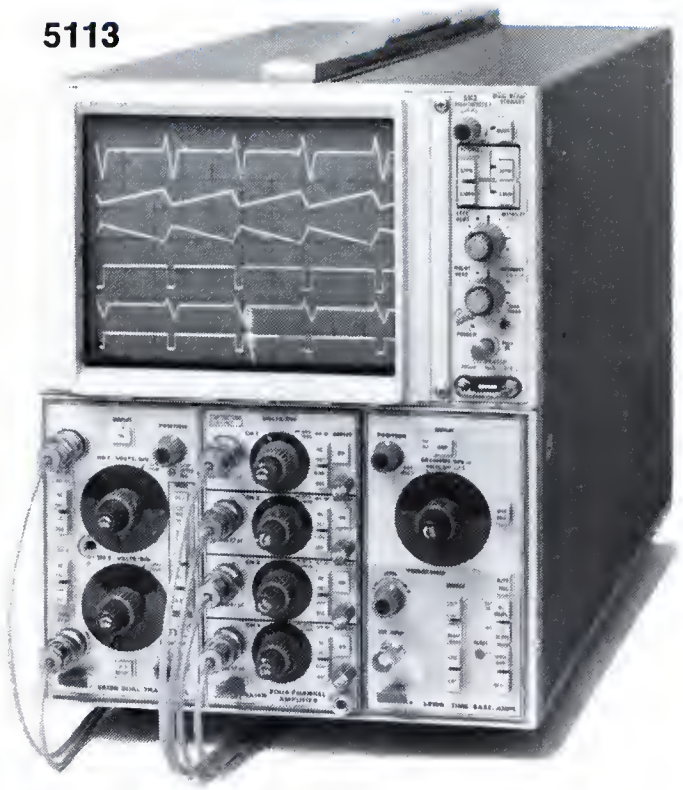
Phosphor — Similar to P1.

Max Stored Writing Speed — At least 20 div/ms.

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

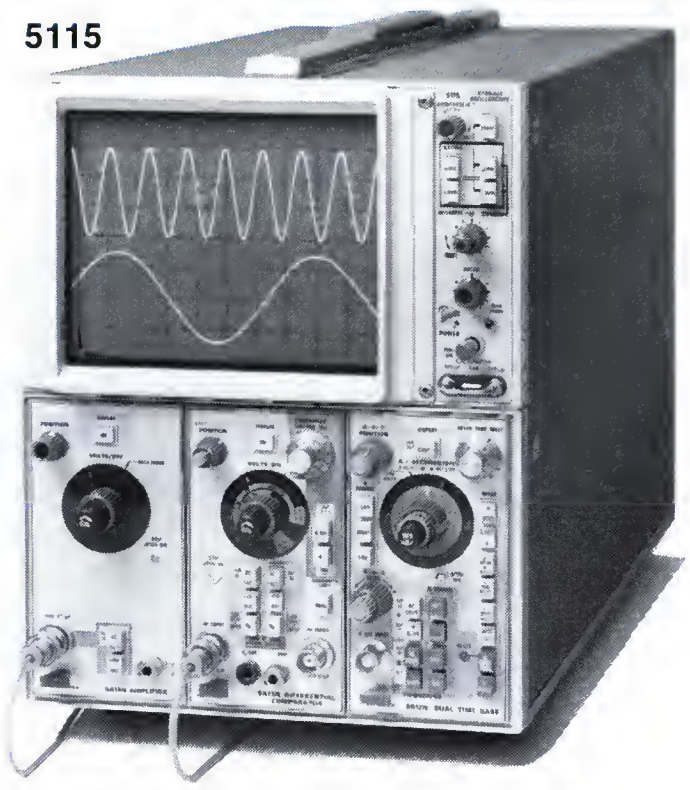
Erase Time — Approx 250 ms.

5113



Dual-beam Bistable Storage

5115



Single-beam Bistable Storage

5113

Dual-beam Bistable Storage Oscilloscope

Two Independent Vertical Systems

Can Display Two Single-shot Signals without timesharing, or up to eight signals in the chop mode

Split-screen Storage. Stored Writing Speed ≥20 div/ms, or ≥200 div/ms with Option 03

The 5113 is a dual-beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms (Option 03 provides 200 div/ms for the center 6 x 8 div). View time is at least 1 hr at normal intensity and can be increased to 10 hr at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. *Both beams are driven by one set of horizontal deflection plates.*

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be observed and recorded.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

Max Stored Writing Speed — At least 20 div/ms. At least 200 div/ms at lower stored brightness (over center 6 x 8 div) with Option 03.

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — Approx 250 ms.

Option 03 Fast Writing Speed CRT — Increases stored writing speed to 200 div/ms (center 6 x 8 div).

**Illuminated graticule available at extra cost.*

5115

Single-beam Bistable Storage Oscilloscope

Fastest Stored Writing Speed in the 5100 Series Line:
≥200 div/ms in Normal-Mode
≥800 div/ms in Enhanced Mode

Storage View Time up to 10 hrs at Reduced Intensity

The 5115 is a single-beam bistable storage oscilloscope with a writing speed of at least 200 div/ms in the normal-mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage view time is at least 1 hr at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hrs at reduced intensity, after which time intensity may be increased to original level. Variable brightness also gives optimum photographic results and allows for the integration of multiple traces.

The 5115 is useful in a wide variety of fields, including education, biophysical engineering, component testing, and industrial electronics.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

Max Stored Writing Speed — At least 200 div/ms in the normal-mode and 800 div/ms in the enhanced mode.

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — Approx 250 ms.

OPTION 07: 5100 SERIES REAR PANEL SIGNAL OUTPUTS

Left and Center Compartments — Two BNC connectors provide access to the CRT-related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output Impedance: 1 kΩ.

Right Compartment (Sweep) — One BNC connector provides access to the CRT-related sweep waveform. Sensitivity: 0.5 V/CRT division; positive-going sawtooth, ≥ 5 V. Output Impedance: 1 kΩ.

Right Compartment (Gate) — One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

X-Y Mode — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

ORDERING INFORMATION

(Plug-ins not Included)

Cabinet Model

5110 Oscilloscope	$1300
5111 Oscilloscope	$1850
5113 Oscilloscope	$2640
5115 Oscilloscope	$1980

Rackmount Model

R5110 Oscilloscope	$1350
R5111 Oscilloscope	$1900
R5113 Oscilloscope	$2690
R5115 Oscilloscope	$1715

OPTIONS

Option 02 Protective Panel Cover (Cabinet Models Only) — The cover protects the front panel and knobs during transportation and storage ..... Add $25

Option 03 Fast Writing Speed CRT (5113, R5113 Only) ..... Add $150

Option 07 Add Rear Panel Signals Out (All Models) ..... Add $75

Option 76 P7 Phosphor (5110, R5110 Only) .. Add $35

Option 78 P11 Phosphor (R110, R5110 Only) . Add $35

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit, Order 040-0583-02 ..... $125

Rackmount-to-Cabinet Conversion Kit, Order 040-0584-03 ..... $125

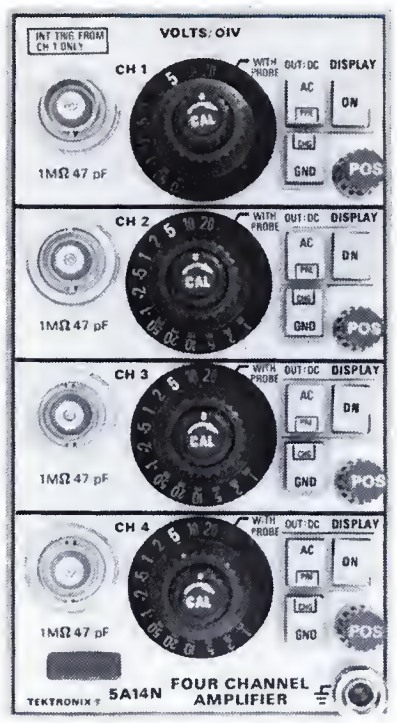
Protective Panel Cover Kit, Order 040-0620-00 ..... $40

Rear Panel Signal Outputs Conversion Kit (Option 07) Order 040-0915-00 ..... $155

For Recommended Cameras — See Camera section, page 262.

Single, Two, and Four-channel Amplifiers

5A14N



Four Trace Dc to 1 MHz

5A14N Amplifier

1 mV/div to 5 V/div

The 5A14N Four Trace Amplifier features simplified front-panel controls and can be used in any 5000 Series Mainframe.

5A14N operating modes are: each channel separately, and alternated or chopped between any combination of channels. Internal trigger is available from channel one only.

CHARACTERISTICS

Bandwidth — Dc coupled, dc to at least 1 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 1 MHz at all deflection factors.

Deflection Factor — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C — 1 MΩ within 1%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Ac coupled, 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A15N Amplifier

1 mV/div to 5 V/div

The 5A15N Single Trace Amplifier features easy to use front-panel controls and can be used in many 5000 Series Mainframe.

Two 5A15Ns (one must be located in the right-hand compartment) provide versatile X-Y operation when used in a 5100 Series Mainframe.

CHARACTERISTICS

Bandwidth — Dc coupled, dc to at least 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

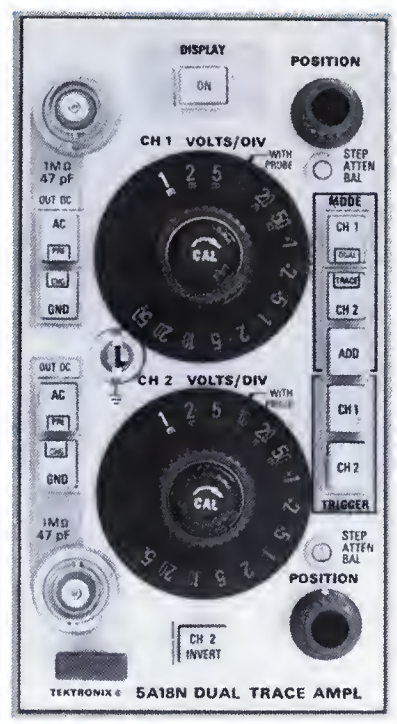
Input R and C — 1 MΩ within 1%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Ac coupled, 350 V dc.

5A15N

Single Trace DC to 2 MHz

5A18N



Dual Trace DC to 2 MHz

5A18N Amplifier

1 mV/div to 5 V/div

The 5A18N Dual Trace Amplifier features easy to use front-panel controls and can be used in any 5000 Series Mainframe.

5A18N operating modes include channel one or two only, channels one and two added, channel two inverted and channel one alternated or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

CHARACTERISTICS

Bandwidth — Dc coupled, dc to at last 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C — 1 MΩ within 1%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Ac coupled, 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A24N

Single Trace DC to 2 MHz

5A24N Amplifier

50 mV/div to 1 V/div Deflection Factors

Easy to Customize

The 5A24N is a low cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5000 Series Mainframes. It contains mode switching, CRT beam positioning, trigger pickoff for basic measurements, and a built-in 3⅜ x 2¾ inch soldering pad matrix for use by the customers who wish to build their own input circuits for special applications. Customer-built circuits are powered through the circuit board which provides access to all mainframe power supplies.

Bandwidth — Dc coupled, dc to at least 2 MHz at 50 mV/div, decreasing to dc to 200 kHz at mid-attenuator range. Ac coupled, 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

Deflection Factor — 50 mV/div, accurate within 3%. Continuously variable, uncalibrated from 50 mV/div to at least 1 V/div.

Input R and C — Approx 100 kΩ, approx 30 pF.

Max Input — 50 volts (dc + peak ac).

ORDERING INFORMATION

5A14N Four Trace Amplifier	**$1135**
5A15N Single Trace Amplifier	**$260**
5A18N Dual Trace Amplifier	**$570**
5A24N Single Trace Amplifier	**$145**

For recommended probes — refer to page 134.

Differential Amplifiers

5A13N

Dc to 2 MHz Bandwidth

1 mV/div to 5 V/div

10,000:1 Cmrr

10,000 Div Effective Screen Height

The 5A13N is a differential comparator plug-in amplifier for the 5000 Series. It incorporates a number of performance features that make it particularly versatile.

Conventional Mode — The 5A13N has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at 2 MHz or 10 kHz for best displayed noise conditions during low-frequency applications. The plus or minus inputs allow normal or inverted displays.

Differential Mode — The 5A13N maintains its conventional features and provides a balanced input for applications requiring rejection of a common-mode signal. The cmrr is 10,000:1 from dc to 20 kHz, decreasing to 100:1 at 2 MHz. The unit rejects up to 15 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 350 V rejection capability above 100 mV/div.

Comparator Mode — The 5A13N provides an accurate positive or negative internal offsetting voltage. A signal of up to ±10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 div by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for applications requiring max resolution. The offset voltage may be externally monitored through a front-panel output.

CHARACTERISTICS

Bandwidth — Dc to 2 MHz. Bandwidth limit mode, dc to 10 kHz. Ac coupled, 2 Hz or less at the lower −3 dB point.

Deflection Factor — 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Input R and C — 1 MΩ, approx 51 pF.

Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Max Ac Coupled Input (Dc Voltage)	±350 V	

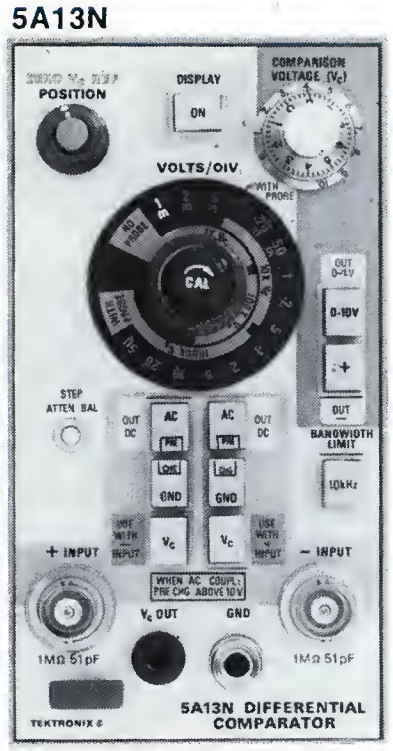
Max Input Gate Current — 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Overdrive Recovery — 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after removal of an overdrive signal between +10 V and −10 V, regardless of overdrive signal duration.

Internal Comparison Voltage — Ranges, 0 V to ±10 V and 0 V to ±1 V. Accuracy, within 0.2% of dial setting plus 5 mV from ±1 V to ±10 V; within 0.2% of dial setting plus 1 mV from ±25 mV to ±1 V on the 0 V to ±1 V range. From 0 V to ±25 mV, use the on-screen display for greater resolution. Vc output R, approx 15 kΩ.

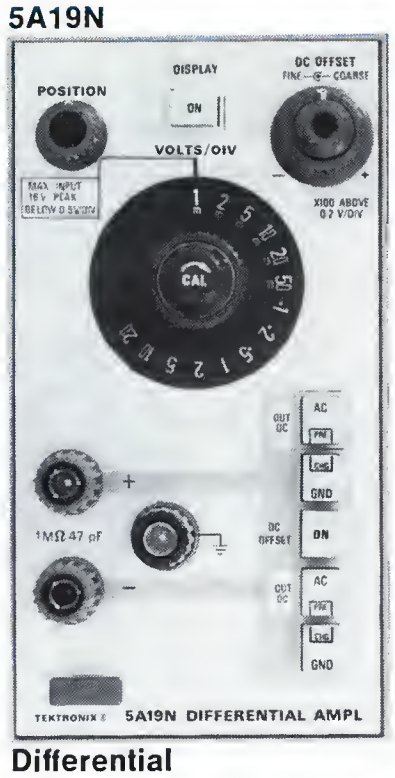
Common-Mode Rejection Ratio — At least 10,000:1, dc to 10 kHz at 1 mV/div to 50 mV/div dc coupled, with up to 20 V p-p sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 V/div to 5 V/div dc coupled, with up to 100 V p-p sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, cmrr is the same as stated for dc coupled. Below 5 kHz ac coupled, cmrr decreases to 400:1 at 10 Hz. Cmrr with two P6060 Probes is at least 400:1 at any deflection factor.

5A13N



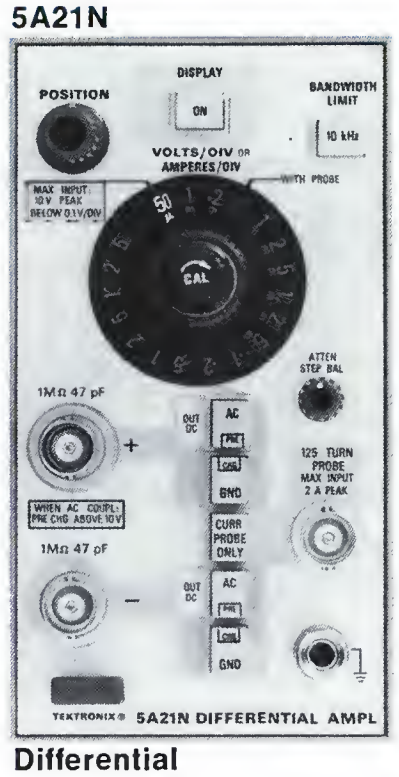
Differential Comparator

5A19N



Differential

5A21N



Differential

5A21N

Dc to 1 MHz Bandwidth

10 kHz Bandwidth Limiter

50 μV/div to 5 V/div

100,000:1 Cmrr

Voltage and Current Probe Inputs

The 5A21N is a 50 μV/div, dc coupled differential amplifier for the 5000 Series. The 5A21N has a current probe input.

VOLTAGE CHARACTERISTICS

Bandwidth — Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C — Voltage mode, 1 MΩ within 0.15%, approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap pre-charged), 10 V peak ac
100 mV/div to 5 V/div	350 V (dc + peak ac)	

Input Gate Current — 100 pA or less (equivalent to 100 μV or less, depending on external loading), at 25°C.

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio — Ac coupled, 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sine wave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sine wave. Cmrr with two P6060 Probes is at least 400:1 at any deflection factor.

CURRENT PROBE INPUT CHARACTERISTICS (with P6021 CURRENT PROBE)

Bandwidth — 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — 0.5 mA/div to 0.5 A/div in 10 calibrated steps (1-2-5 sequence). Accurate within 3%. Uncalibrated, continuously variable between steps and to 1.25 A/div.

Max Input Current — 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise — 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.

5A19N

Dc to 2 MHz Bandwidth

1 mV/div to 20 V/div

Dc Offset

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000 Series Mainframe for Y-T displays, or in the right compartment for X-Y displays.

Bandwidth — Dc coupled, dc to at least 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor — 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 50 V/div.

Input R and C — 1 MΩ within 0.3%, approx 47 pF.

Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Max Ac Coupled Input (Ac Voltage)	±350 V	
Dc Offset Range	+15 V to −15 V	+350 V to −350 V

Common-Mode Rejection Ratio — Dc coupled, 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

ORDERING INFORMATION

5A13N Differential Comparator Amplifier **$1020**

5A19N Differential Amplifier **$330**

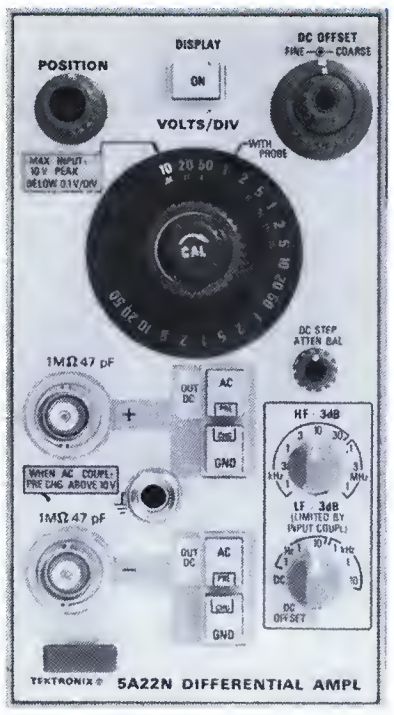
5A21N Differential Amplifier **$465**

Option 01 (includes P6021, 5 ft current probe) ..... **Add $150**

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series Mainframes only). Contact your local Tektronix Field Engineer for details.

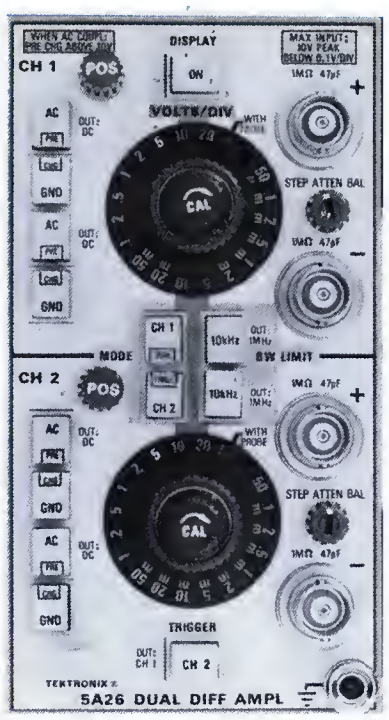
For recommended probes — refer to page 134.

Differential and Dual Differential Amplifiers



5A22N

Differential



5A26

Dual Differential

5A22N

Dc to 1 MHz Bandwidth

10 μV/div to 5 V/div

100,000:1 Cmrr

Selectable Upper and Lower −3 dB Points

Dc Offset

The 5A22N is the most versatile of the 5000 Series Differential Amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

CHARACTERISTICS

Bandwidth — HF −3 dB point: selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accurate to within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF −3 dB point: selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accurate to within 20% of selected frequency. Ac coupled, 2 Hz or less.

Deflection Factor — 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Common-Mode Rejection Ratio — Ac coupled, 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sine wave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sine wave. Cmrr with two P6060 Probes is at least 400:1 at any deflection factor.

Signal and Offset Range

Deflection Factor Settings	10 μV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±12 V	±350 V
Max Ac Coupled Input (Dc Voltage)	±350 V Dc rejection, at least 4 x 10^5:1	
Dc Offset Range	+0.5 V to −0.5 V	+50 V to −50 V

Input R and C — 1 MΩ within 0.15%, approx 47 pF.

Overdrive Recovery — 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

Max Input Gate Current — 200 pA or less.

Displayed Noise — 20 μV at max bandwidth, source resistance 25 Ω or less, measured tangentially.

Drift with Temperature — 100 μV/°C or less.

5A26

Two Differential Amplifiers in One Plug-In

50 μV/div Sensitivity at 1 MHz

100,000: 1 Cmrr

CRT Readout

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000 Series Laboratory Oscilloscopes. It may be used in any 5000 Series Mainframe.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode rejection ratio, *CRT readout in any standard 5400 Series Mainframe,* trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time in the chop or alternate mode.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

CHARACTERISTICS

Number of Differential Channels — Two.

Bandwidth — Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor — 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

CRT Readout — CRT readout of deflection factors. Functional in CRT readout-equipped 5400 Series Oscilloscopes, nonfunctional in 5100 Series Oscilloscopes.

Input R and C — 1 MΩ within 0.15% paralleled by approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 10 V peak ac
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

Input Gate Current — 100 pA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio

Dc Coupled 50 μV/div to 50 mV/div	At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sine wave
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sine wave
Ac Coupled 50 μV/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz
With 2 P6062A Probes	400:1 at 10X probe attenuation

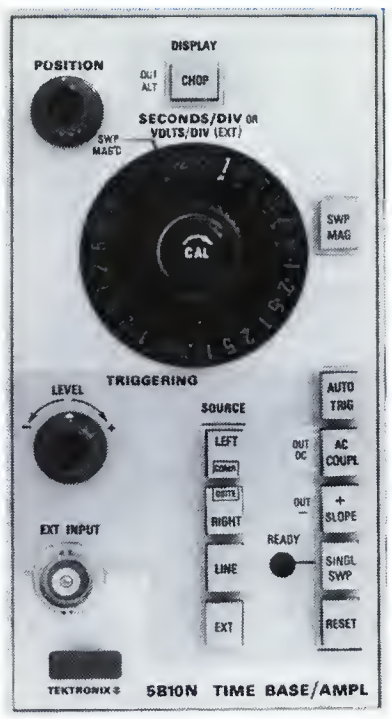
ORDERING INFORMATION

5A22N Differential Amplifier $835

5A26 Dual Differential Amplifier $900

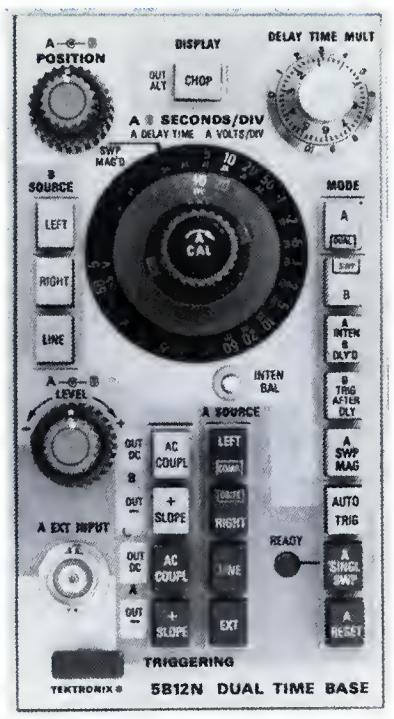
For recommended probes — refer to page 134.

Time Bases



5B10N

Single Sweep Time Base



5B12N

Dual Sweep Time Base

5B10N

100 ns/div to 5 s/div Calibrated Time Base

Single Sweep

Direct Readout X10 MAG

Provides Alternate and Chopped Displays

50 mV/div and 500 mV/div External Input

The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5000 Series Oscilloscopes. An external input allows use of the 5B10N as a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

Multiple triggering modes may be pushbutton selected with the 5B10N. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

CHARACTERISTICS

Sweep Rates — 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy — Unmagnified, within 3% from 1 μs/div to 1 s/div, and within 4% at 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy.

TRIGGERING

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

Auto Trig — Same as above except signal rate requirements are 15 Hz and above.

Single Sweep — Same as for ac and dc coupled.

External Trigger Input — Max input is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor — 50 mV/div and 500 mV/div, accurate within 3%. X10 variable extends range to at least 5 V/div.

Bandwidth — Dc coupled, dc to at least 1 MHz. Ac coupled, 50 Hz or less to at least 1 MHz.

Input R and C — 1 MΩ within 2%, approx 70 pF.

Max Input Voltage — 350 V (dc + peak ac).

5B12N

100 ns/div to 5 s/div Calibrated Time Base

Dual and Delayed Sweep

Direct Readout X10 MAG

The 5B12N is a time base for generating single, dual, or delayed sweeps in 5000 Series Oscilloscopes. The 5B12N is normally used in the right plug-in compartment but is compatible with the vertical deflection compartments as well.

The display modes are A sweep, B sweep, A intensified −B delayed, and dual sweep. Each mode is selectable by pushbutton switches. Triggering sources for A and B sweep include left and right plug-in, line, and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep is triggerable after the delay time.

When operated in the dual-sweep mode in a dual-beam oscilloscope with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers; four traces will be displayed. Both sweeps are displayed simultaneously in chop mode.

When operated in the dual-sweep mode in a single-beam oscilloscope with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode pushbutton selects chop or alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

CHARACTERISTICS

A Sweep Rates — 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

A Sweep Accuracy — Unmagnified, within 3% from 1 μs/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Magnified, displays accurate to within 1% in addition to specified time-base sweep accuracy.

B Sweep Rates — 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

B Sweep Accuracy — Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, 0.5 μs/div, 0.2 s/div, and 0.5 s/div.

TRIGGERING

The following applies to the A and B trigger except as noted.

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

*A Trigger only.

B sweep operates in triggered or free-run mode after delay time.

Auto Trig — Same as above on signal rates of 15 Hz and above.

The following characteristics apply to the A trigger only.

Single Sweep — Same as for ac and dc coupled.

External Trigger Input — Max input voltage is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by approx 70 pF. Trigger level voltage range is +5 V to −5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Accuracy — 1 μs/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%.

Delay Time Multiplier Range — 0.2 to 10.2 times the time/div setting.

Delay Time Multiplier Incremental Linearity — Within 0.2%.

Differential Time Measurement Accuracy — Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

Jitter — Less than 0.05% of the time represented by one div of the delaying sweep selected.

EXTERNAL HORIZONTAL MODE

Deflection Factor — 50 mV/div and 500 mV/div accurate to within 3%. X10 variable extends range to at least 5 V/div.

Bandwidth — Dc coupled, dc to at least 1 MHz. Ac coupled, 50 Hz or less to at least 1 MHz.

Input R and C — 1 MΩ within 2%, approx 70 pF.

Max Input Voltage — 350 V (dc + peak ac).

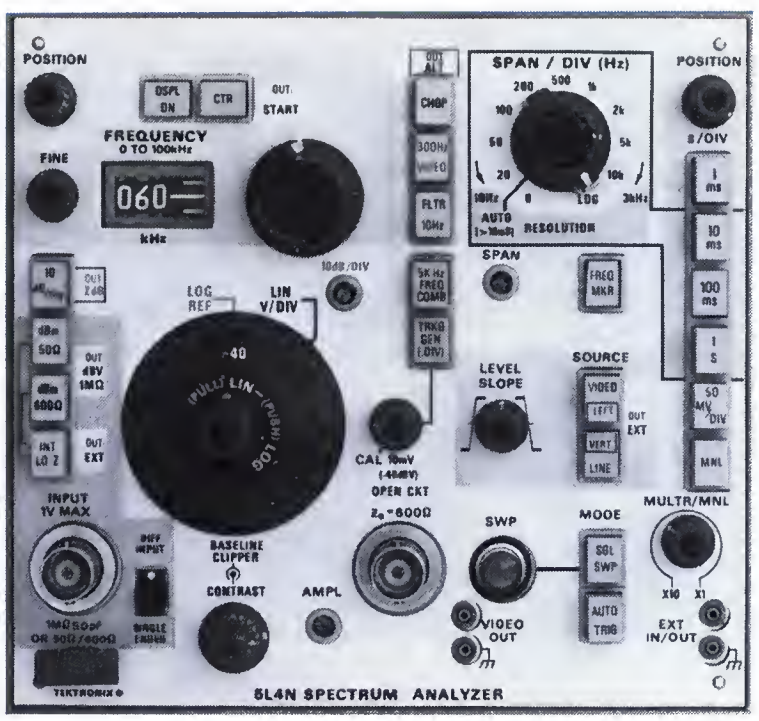
ORDERING INFORMATION

5B10N Time Base/Amplifier **$405**

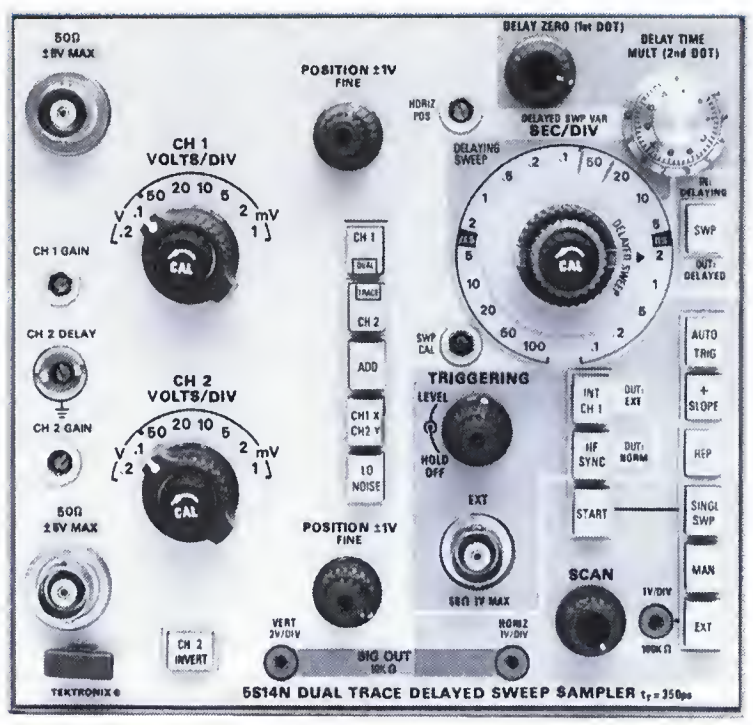
5B12N Dual Time Base **$860**

Curve Tracers, Spectrum Analyzer, and Dual Trace Sampler

5CT1N Curve Tracer



5L4N Spectrum Analyzer



5S14N Dual Trace Delayed Sweep Sampler

5CT1N Curve Tracer

• Test Semiconductor Devices to 0.5 W • 10 nA/div to 20 mA/div Vertical Deflection Factors • 0.5 V/div to 20 V/div Horizontal Deflection Factors • For a complete description see page 237.

5L4N Spectrum Analyzer

• Low Cost • 0-100 kHz Frequency Range • Resolution Bandwidth 10 Hz to 3 kHz • Log and Linear-Span Modes • Auto Resolution • For a complete description see page 249.

5S14N Sampler

Dc to 1 GHz Bandwidth

Dual Trace, 2 mV/div Sensitivity

Calibrated Delayed Sweep

Simplified Triggering

Operational Ease of Conventional Oscilloscope

Two-Dot Time Measurements

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-width plug-in unit designed to operate in all 5000 Series Mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide new economy and ease of operation.

Two identical amplifier channels provide dual-trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time Multiplier Dial by the selected time per division.

AMPLIFIER CHARACTERISTICS

Modes — Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 vertical (Y), Channel 2 horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc to 1 GHz.

Rise Time — 350 ps or less.

Step Aberrations — +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, tested with 284 Pulse Generator.

Deflection Factor — 1 mV/div to 0.2 V/div in 8 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Max Input Voltage — ±5 V.

Input Signal Range — 2 V p-p max within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (tangentially measured). Low noise pushbutton reduces random noise by factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

Channel Delay Difference — Adjustable to zero or for any time difference up to at least 1 ns.

TIME BASE CHARACTERISTICS

Scan Modes — Repetitive, Single, Manual, or External.

Delaying Sweep — May be used as CRT time base or as a delay generator for the Delayed Sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the Delaying Sweep mode is selected for the time base, two bright dots in the trace are generated which may be positioned anywhere on the displayed waveform. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The Delayed Sweep may be started with zero delay time with respect to the start of the Delaying Sweep. Or the start may be delayed by any time interval up to that represented by ten div of the Delaying Sweep selected.

Horizontal Signal Output — 1.0 V per div of horizontal deflection; 10 kΩ source resistance.

DELAYING SWEEP CHARACTERISTICS

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3% excluding first ½ div of displayed sweep.

Delay Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first 9 div of the Delaying Sweep selected.

Delay Time (2nd Dot) — Adjustable to any portion of the time interval represented by ten div of the Delaying Sweep selected.

Delay Accuracy — Within ±1% of ten div when measurement is made within the last 9.5 div.

DELAYED SWEEP CHARACTERISTICS

Range — 100 ps/div to 100 μs/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first ½ div of displayed sweep.

Start Delay — Depends on the Delaying Sweep time selected and the setting of the Delay Time Mult dial. Adjustable from Zero to any time interval up to that represented by 10 div of the Delaying Sweep selected. The Delaying Sweep start point corresponds to the second bright dot position.

Delay Jitter — Less than 0.05% of the time represented by 1 div of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

Signal Source — Interval from channel 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V at instants when either a + slope or a − slope of the triggering signal crosses that level.

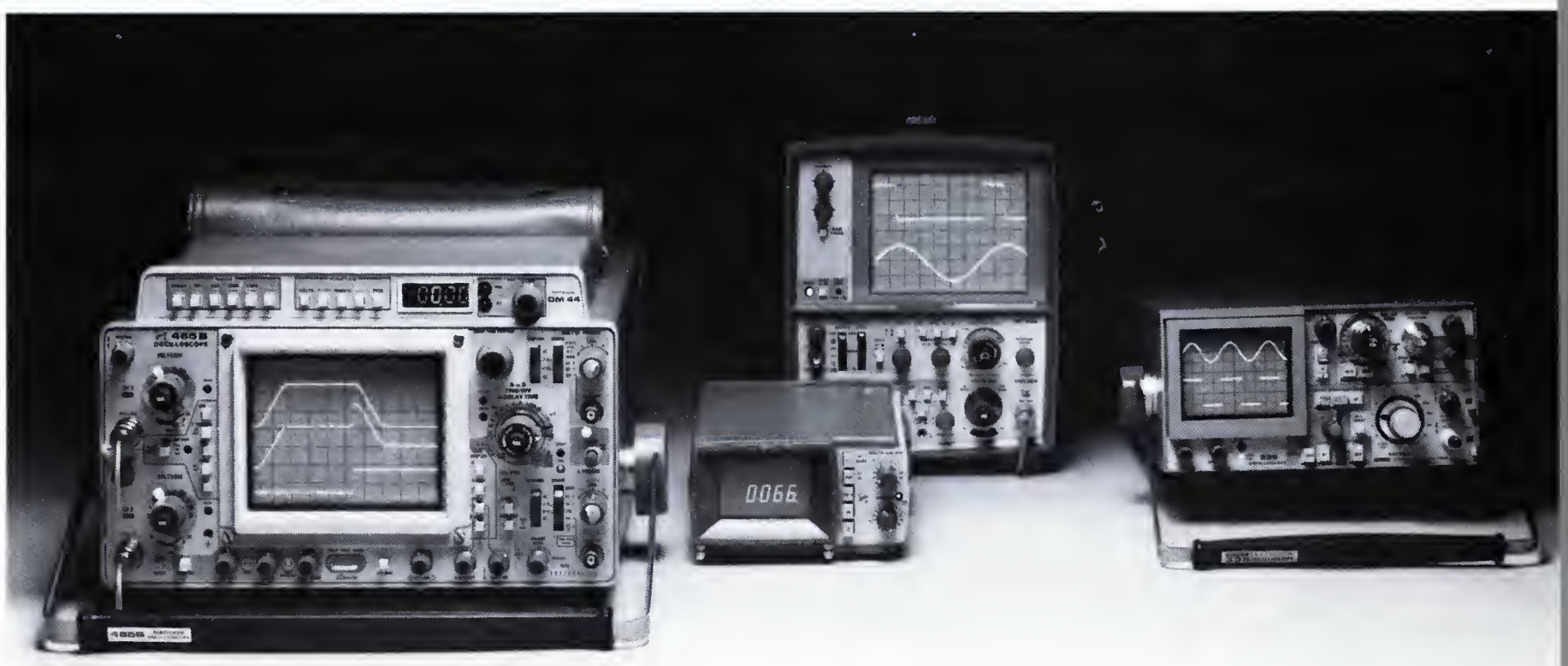
Auto Triggered Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so a trace may always be generated and displayed. The trigger level range automatically adjusts to approx the p-p voltage of the signal.

Holdoff — Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode — For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

5S14N Sampler **$4615**

Portable Oscilloscopes



Choose the TEKTRONIX Portable that's right for your application.

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For Accuracy and Versatility in the Field, Take One of Our 22 Portable Oscilloscopes.

	Product	Bw	Dual Trace	Delayed Sweep	Fastest Sweep Rate	Other Special Features	Price*
Storage Models	468	100 MHz @ 5 mV/div	yes	yes	2 ns/div	10 MHz Digital Storage	$5000
	466	100 MHz @ 5 mV/div	yes	yes	5 ns/div	3000 div/μs stored writing speed	6275
	464	100 MHz @ 5 mV/div	yes	yes	5 ns/div	110 div/μs stored writing speed	5115
	434	25 MHz @ 10 mV/div	yes		20 ns/div	Split-screen storage	4150
	314	10 MHz @ 1 mV/div	yes		100 ns/div	Only 10.5 lbs (4.8 kg)	3170
	214	500 kHz @ 10 mV/div	yes		1 μs/div	Only 3.5 lbs (1.6 kg)	1925
	T912	10 MHz @ 2 mV/div	yes		50 ns/div	Low-cost bistable storage	1800
Nonstorage Models	485	350 MHz @ 5 mV/div	yes	yes	1 ns/div	Widest bw in a portable	6575
	475A	250 MHz @ 5 mV/div	yes	yes	1 ns/div	High-performance 250 MHz portable	4350
	475	200 MHz @ 2 mV/div	yes	yes	1 ns/div	Highest gain-bw in a portable	3910
	465B	100 MHz @ 5 mV/div	yes	yes	2 ns/div	Cost effective for 100 MHz bw	2895
	465M	100 MHz @ 5 mV/div	yes	yes	5 ns/div	Triservice standard 100 MHz scope	3150
	455	50 MHz @ 5 mV/div	yes	yes	5 ns/div	Cost effective for 50 MHz bw	2450
	335	35 MHz @ 10 mV/div	yes	yes	20 ns/div	Only 10.5 lbs (4.8 kg)	2565
	305	5 MHz @ 5 mV/div	yes		0.1 μs/div	Autoranging DMM	2020
	221	5 MHz @ 5 mV/div			100 ns/div	Only 3.5 lbs (1.6 kg)	1495
	213	1 MHz @ 20 mV/div			400 ns/div	DMM/Oscilloscope @ 3.7 lbs (1.7 kg)	1925
	212	500 kHz @ 10 mV/div	yes		1 μs/div	Low cost for dual trace & battery	1475
	T935A	35 MHz @ 2 mV/div	yes	yes	10 ns/div	Variable trigger-holdoff and differential	1720
	T932A	35 MHz @ 2 mV/div	yes		10 ns/div	Delayed sweep and differential	1390
	T922	15 MHz @ 2mV/div	yes		20 ns/div	Low-cost dual-trace scope	1090
	T922R	15 MHz @ 2mV/div	yes		20 ns/div	Rackmount version of T922	1555
	T921	15 MHz @ 2mV/div			20 ns/div	Lowest-cost Tektronix Portable	930

*U.S. sales prices are F.O.B. Beaverton, OR. For price and availablity outside the United States, please contact the nearest Tektronix Field Office, Distributor or Representative. Prices are subject to change without notice.

350 MHz Dual Trace Oscilloscope

485

- 350 MHz at 5 mV/div
- 1 ns/div Sweep Rate
- 3.0 div/ns Writing Speed
- 1 MΩ and 50 Ω Input Impedances
- Input Protection 50 Ω Internal
- Automatic Deflection Factor Readout
- Pushbutton Ext Trigger View
- Battery Operation (Optional)
- Weighs ≈21 lb

At just 21 pounds, the 1 ns/div dual-trace 485 is the only true portable 350 MHz oscilloscope on the market. This wide bandwidth is one reason why the 485 is highly compatible with today's increasing technology.

Many features contribute to the 485's extraordinary overall performance. Fast 3.0 div/ns writing speed is one, making it especially attractive for use in field research environments.

The 485 features a wide bandwidth at its full 5 mV/div vertical sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ). Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes.

Internal detection circuitry protects the 50 Ω input by automatically disconnecting when the signal exceeds approximately 5 V rms.

You no longer have to mentally compensate for attenuating probes. Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen V/div when the recommended 10X or 100X probes are used.

And you always know exactly where you are in a pulse train when making a delayed sweep measurement. An alternate sweep mode allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, you can view the intensified zone and the delayed display simultaneously.

The external trigger signal can be easily viewed on the 485. A front-panel pushbutton automatically routes the external signal used to trigger Time Base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

On the 485, focus is always correct in single-shot photography. An autofocus circuit eliminates the need to readjust the focus each time the intensity is changed.

When commercial power is not available, use the 1105 Battery Power Supply. It weighs only 19.5 pounds, and lets you take the high-performance 485 virtually anywhere.

Often chosen as a general-purpose scope for computer and electronic servicing environments because of its fast writing speed and wide bandwidth, the 485 can also be found in specialized and unusual applications. For example, to maintain a ground-based laser/radar acquisition system, the 485's alternate sweep switching mode proved an important factor.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Rise Time — (at all deflection factors from 50 Ω terminated source).

	−15°C to +35°C	+35°C to +55°C
50 Ω	Dc to 350 MHz, 1 ns	Dc to 300 MHz, 1.2 ns
1 MΩ	Dc to 250 MHz, 1.4 ns	Dc to 200 MHz, 1.8 ns

*Measured at −3 dB. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Lower −3 dB point, ac coupling 1X probe: 1 kHz or less for 50 Ω, and 10 Hz or less for 1 MΩ. 10X probe: 100 Hz or less for 50 Ω, and 1 Hz or less for 1 MΩ.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±2%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

Display Modes — Ch 1, Ch 2 (normal and inverted), X-Y (Ch 1-Y and Ch 2-X), ADD (Ch 1 ± Ch 2).

CMRR — Common-mode rejection ratio at least 20 dB at 50 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X, 10X, and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

Selectable Input Impedance — 50 Ω and 1 MΩ impedances are available at a single BNC connector by pushbutton selection.

50 Ω ±0.5%; 1.15:1 or less from 20 mV/div to 5 V/div to 350 MHz, vswr 1.25:1 or less at 5 mV/div to 10 mV/div.

Input R and C — 1 MΩ ±1% paralleled by approx 20 pF.

50 Ω Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

Max Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approx: 5 V rms continuous 0.1 watt-second for instantaneous voltages of 5 V to 50 V.	
	Ac coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
1 MΩ	Dc coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
	Ac coupled	500 V (dc + peak ac). 500 V p-p fo 1 kHz.

Selectable Input Coupling — Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

Delay Line — Permits viewing leading edge of displayed waveform.

Probe Power — Connectors provide correct voltages for two optional P6201 FET Probes.

HORIZONTAL DEFLECTION

Time Base A and B — Calibrated sweep range; 1 ns/div to 0.5 s/div (1-2-5 sequence).

Variable Time Control — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy, center 8 div

Sweep Rate	+15°C to +35°C	−15°C to +55°C
1 ns/div to 20 ns/div	±3%	±5%
50 ns/div to 0.1 s/div	±2%	±4%
0.2 s/div and 0.5 s/div	±3%	±5%

Horizontal Display Modes — A, intensified, alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2, and 5 ns/div. B ends A for increased intensity in the delayed mode.

Alternate Display Modes — Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed sweep approx 4 div from the A sweep).

CALIBRATED SWEEP DELAY

Delay Time Range — 0 to 10X delay time/div setting of 10 ns/div to 0.5 s/div.

Differential Delay Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	± (1% of measurement +0.2% of full scale)
50 ns/div to 1 ms/div	± (0.5% of measurement +0.1% of full scale)
2 ms/div to 0.5 s/div	± (1% of measurement +0.1% of full scale)

Full scale is 10 times the delay time/div setting.

Jitter — 1 part or less in 20,000 of 10X the time/div setting.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for faster than 0.2 s/div.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity

Coupling	To 50 MHz	To 350 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	20 mV	100 mV
Ac	Signals below 16 Hz are attenuated	
Ac Lf Reject	Signals below 16 kHz are attenuated	
Ac Hf Reject	Signals below 16 Hz and above 50 kHz are attenuated	

Jitter — 0.1 ns or less at 350 MHz at 1 ns/div.

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for Ext ÷ 10.

A Sources — Internal, line, external, external ÷ 10.

B Sources — B runs after delay time, internal, external, external ÷ 10.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. Max input voltage; 500 V (dc + peak ac), 500 V p-p to 1 kHz.

X-Y OPERATION

Full Sensitivity X-Y (Ch 1 Vert, Ch 2 Horiz) — 5 mV/div to 5 V/div, accurate ±2%. Y-axis bandwidth identical to Channel 1. X-axis bandwidth is dc to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

DISPLAY

Crt — 8 x 10 div display, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2 div increments. P31 Phosphor standard; P11 optional. 21 kV accelerating potential.

Photographic Writing Speed — At least 1.5 div/ns with standard P31 Phosphor and at least 3 div/ns with optional P11 Phosphor using the TEKTRONIX C-31R Camera and 3000 speed film.

Auto Focus — Automatically maintains beam focus for all intensity settings.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

Z-Axis Input — Rise time ≃15 ns. Input R ≃500 Ω. +0.2 V (dc to 20 MHz) decreases intensity. + 2 V (dc to 2 MHz) blanks max intensity trace.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −35°C to +75°C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator — Output resistance is 450 Ω with a rise time (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%. Amplitude is 5 V ±0.5% into 1 MΩ and 0.5 V ±1% Into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA ±1%. Selectable repetition rates are 1 kHz and 1 MHz ±0.25%. Specifications apply over +15°C to +35°C range.

A Sweep Output — Open circuit, approx 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs — Open circuit, approx 4 V positive-going rectangular pulse; into 50 Ω approx 0.5 V.

Power Requirements — Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 W max power consumption at 115 V. Line frequency 48 to 440 Hz.

	Cabinet		Rackmount	
Dimensions	**In**	**cm**	**In**	**cm**
Height	6.6	16.8	7.0	17.7
Width	12.0	30.5	19.0	48.3
Depth			18.0	45.7
(handle extended)	20.6	52.3		
(handle not extended)	18.5	47.0		
Weights (Approx)	**lb**	**kg**	**lb**	**kg**
Net (with accessories)	24	10.9		
Net (without accessories)	21	9.5	26.2	11.9
Shipping	33	15	54	24.5

INCLUDED ACCESSORIES

50 Ω, 18 inch BNC cable (012-0076-00), two BNC jack posts (012-0092-00), two 50 Ω terminators (011-0049-01) clear filter (386-0118-00), four 3 amp fuses (159-0015-00), accessory pouch (016-0535-00) or (016-0537-00). Rack models also include mounting hardware and slide out assemblies.

ORDERING INFORMATION

485 Oscilloscope **$6575**

R485 Oscilloscope, 7 in Rack Model .. **$6735**

INSTRUMENT OPTIONS

Option 04 **Emc Modification** ..... **Add $100**

Option 78 **P11 Phosphor** ..... **Add $35**

For more information on instrument options, see your Tektronix Field Engineer, Distributor, or Representative.

OPTIONAL ACCESSORIES

Probes —

Input Terminal	Probe Type	Attenuation	Input Impedance	Bandwidth* with 485
50 Ω Input	P6056 6 ft	10X	500 Ω 1 pF	350 MHz
	P6057 6 ft	100X	5000 Ω 1 pF	350 MHz
	P6201 FET 2 Meter	1X	100 kΩ 3 pF	330 MHz
		10X Head	1 MΩ 1.5 pF	
		100X Head	1 MΩ 1.5 pF	
50 Ω or 1 MΩ	P6202 2 Meter	10X 100X Head (optional)	10 MΩ 2 pF	285 MHz
	P6106 2 Meter	10X	10 MΩ 13 pF	250 MHz
1 MΩ Input	P6063B 6 ft	1X Switchable 10X	1 MΩ 12 pF	6 MHz
			10 MΩ 14 pF	200 MHz

Current Probe	Probe Type	Calibration	Insertion Impedance	Bandwidth* with 485
	P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	130 MHz

*Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Current Loop Adapter — The adapter provides an accurate 50 mA square-wave calibrator when connected to the 485 voltage calibrator. The rise time is approx 25 ns.

Order 012-0341-00 ..... **$45**

50 Ω 5X Pad — Provides reverse termination for the calibrator.

Order 011-0060-02 ..... **$35**

Folding Viewing Hoods — Folds to 7/16 x 4½ x 7½ In. (1.2 x 11.5 x 19.1 cm).

Order 016-0274-00 ..... **$15**

Folds to 7/16 x 6¾ x 13¾ in. (1.4 x 17.2 x 34.9 cm).

Order 016-0082-00 ..... **$15**

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.

Order 200C **$235**

1105 Battery Power Supply — Provides 2.3 hours of battery operation.

Order 1105 Battery Power Supply **$1100**

Rack Adapter — 016-0558-00 ..... **$250**

RECOMMENDED CAMERAS

C-30BP General Purpose Camera — Includes 016-0306-00 mounting adapter.

Order C-30BP **$1050**

C-31BR High Speed Camera — Includes 016-0306-00 mounting adapter.

Order C-31BR **$1210**

For further information see Camera section.

Tektronix offers maintenance training classes on instruments in the 400 Series and multi-media training packages on Digital Counter and Meter Concepts and Basic Oscilloscope Maintenance Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

250 MHz and 200 MHz Dual Trace Oscilloscopes

475/475A

1 ns/div Sweep Rate (475) (475A) with X10 Sweep Magnifier

Trigger View

Versatile Trigger Selection

Battery Operation (Optional)

Weighs ≈ 22.75

Both of these Tektronix Portables feature high performance and light weight for making complex measurements in the field.

1) The 475A provides a 250 MHz bandwidth at 5 mV/div. It features wider bandwidth than the 475, plus a more concise spot size and trace for particular applications.

2) With 200 MHz at 2 mV/div, the 475 features better sensitivity than the 475A. This bandwidth/sensitivity combination is useful in a wide variety of measurements.

Both the 475 and 475A offer 1% (1 ns/div) timing accuracy, which can be critical in servicing computers.

Both oscilloscopes are light, compact, and rugged for portability and durability, yet each contains a large, bright 8 x 10 cm CRT. Operation has been simplified by single-function pushbuttons, control knob design, layout, and color-coordinated front panels.

Determining deflection factors used to be error-prone and costly. Now, it's a problem of the past...readout lights behind knob skirts automatically indicate the proper probe tip deflection factors for recommended 1X and 10X probes.

Measuring with respect to ground is important in many applications. This is controlled at the probe when dc-coupled by simply pressing the small ground reference button on recommended probes.

You can choose from the 1105 or 1106 Battery Packs. Both are small and light weight, and provide a ready solution for making accurate measurements in difficult environments such as conducted emc, ground loops, power line fluctuations or where line power is nonexistent.

Applications for these instruments are widespread. The 475 performs tests and measurements aboard flight test aircraft, in both stationary and portable modes.

CHARACTERISTICS

All characteristics are common to the 475 and 475A except where indicated.

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth* and Rise Time — (at all deflection factors from 50 Ω terminated source)

	−15°C to +40°C	+40°C to +55°C
475	Dc to 200 MHz, 1.8 ns	175 MHz, 2.0 ns
475A	Dc to 250 MHz, 1.4 ns	250 MHz, 1.4 ns

*Measured at −3 dB, Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Lower −3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

Deflection Factor at BW
475 — 2 mV/div to 5 V/div
475A — 5 mV/div to 10 V/div

1-2-5 sequence, accurate ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div (475) to at least 25 V/div (475A). In cascade mode sensitivity is approx 400 μV/div (475); and approx 2.5 mV/div (475A). Cascaded bandwidth is at least 50 MHz (475/475A) when signal out is terminated in 50 Ω.

Display Modes — Ch 1; Ch 2 (normal and inverted), alternate, chopped — approx 1 MHz rate), added; X-Y (Ch 1-X, Ch 2-Y).

CMRR — Common-mode rejection ratio at least 20 dB at 50 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by approx 20 pF.

Max Input Voltage

Dc coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

Probe Power — Connectors provide correct voltages for two optional P6201 FET Probes.

HORIZONTAL DEFLECTION

Time Base A and B — 0.01 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends max sweep rate to 1 ns/div.

Variable Time Control — Time Base provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±1%	±2%
Magnified	±2%	±3%

Horizontal Display Modes — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep — Displays A sweep for period determined by delay-time position control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range

0 to X10 delay time/div settings of 50 ns to 0.5 s (minimum delay time is 50 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
over one or more major dial divisions	±1%
less than one major dial division	±0.01 major dial division

Jitter — 1 part or less in 50,000 (0.002%) of X10 the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling —

Coupling		475		475A	
		To 40 MHz	At 200 MHz	to 40 MHz	At 250 MHz
Dc	Internal	0.3 div deflection	1.5 div deflection	0.3 div deflection	2.0 div deflection
	External	50 mV	250 mV	50 mV	250 mV
	External ÷ 10	500 mV	2.5 V	500 mV	2.5 V
Ac		Requirements increase below 60 Hz			
Ac Lf Reject		Requirements increase below 50 kHz			
Ac Hf Reject		Requirements increase below 60 Hz and above 50 kHz			

475 Jitter — 0.2 ns or less at 200 MHz and 1 ns/div.

475A Jitter — 0.2 ns or less at 250 MHz and 1 ns/div.

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with external ÷10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

A Sources — Norm, Ch 1, Ch 2, line, external, and external ÷10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

Full-sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 2 mV/div to 5 V/div (475), 5 mV to 10 V/div (475A) accurate ±3%. Bandwidth is dc to at least 3 MHz. Phase difference between amplifiers is 1° or less from dc to 1 MHz.

DISPLAY

Crt — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 Phosphor standard; P11 optional. 18 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A pre-set intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

Shock — Operating and nonoperating: 30 g's ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — Ch 2 vertical signal is dc to at least 50 MHz (−3 dB), and approx 10 mV/div terminated into 50 Ω, and approx 20 mV/div terminated in 1 MΩ.

Gate Outputs — Positive gates from both time bases (approx 5 V).

Power Requirements — Quick-change line voltage selector provides six ranges; 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, or 100 watts max at 115 V and 60 Hz. Operation from 12 or 24V dc is available with Option 07.

Dimensions	Cabinet In	Cabinet cm	Rackmount In	Rackmount cm
Height (w/o pouch)	6.2	15.7	7.0	17.7
Width (with handle)	12.9	32.8	19.0	48.3
Depth (with panel cover)	18.1	46.0	18.0	45.7
Depth (handle extended)	20.3	51.6		
Weights (approx)	**lb**	**kg**	**lb**	**kg**
Net (without panel cover)	22.8	10.3	29.4	13.3
Net (with panel cover and accessories)	25.3	11.5		
Shipping	37.0	16.7	58.0	26.3

INCLUDED ACCESSORIES

Two P6106 10X probes (010-6106-03), blue accessory pouch (016-0594-00), clear pouch (016-0537-00), blue CRT light filter (337-1674-00), clear CRT light filter (337-1674-01), BNC male to ground wire (134-0016-01), two 1½-amp fuses (159-0016-00), one ¾-amp fuse (159-0042-00). Rack models also include mounting hardware and slide out assemblies, do not include accessory pouches.

ORDERING INFORMATION

475 Oscilloscope **$3910**

475A Oscilloscope **$4350**

R475 Rackmount Oscilloscope **$4070**

R475A Rackmount Oscilloscope **$5005**

475 DM 44 DM 44 info on page 155 ... **$4405**

475A DM 44 (order 475A 44) **$4845**

INSTRUMENT OPTIONS

Option 01 delete temperature probe on DM 44 ..... **Sub $75**

Option 04 Emc Modification ..... **Add $135**

Option 07 Ext Dc Operation ..... **Add $210**
Option 07 cannot be ordered with DM 44.

Option 78 P11 Phosphor ..... **Add $35**

Modification kits for field conversion of existing 475s or 475As to Option 04, Option 07, or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Field Engineer, Distributor, or Representative for information.

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 475	Bandwidth* with 475A
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz	6 MHz
	Switchable 10X	10 MΩ 14 pF	145 MHz	160 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ 2 pF	185 MHz	220 MHz
	100X Head	10 MΩ 2 pF	185 MHz	220 MHz
	Ac Head	10 MΩ 4 pF	185 MHz	220 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 475**	**Bandwidth with 475A**
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	125 MHz	160 MHz

*Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Folding Polarized Viewing Hood —
Order 016-0180-00 ..... **$27**

Collapsible Viewing Hood — Binocular —
Order 016-0566-00 ..... **$15**

Protective Cover — Waterproof, blue vinyl
Order 016-0554-00 ..... **$17**

Mesh Filter — Improves contrast and emc filtering
Order 378-0726-01 ..... **$33**

SCOPE-MOBILE® Cart — Occupies less than 18 in. aisle space, has storage area in base.
Order 200C **$235**

1106 Battery Pack (for use with Option 07) **$850**

1105 Battery Power Supply **$1100**

Rack Adapter (not for use with DM 44) —
Order 016-0556-00 ..... **$250**

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Compact Camera
Includes 016-0301-01 mounting adapter/corrector lens.
Order C-30BP Option 01 ..... **$1075**

For further information see Camera section.

Tektronix offers maintenance training classes on instruments in the 400 Series and multi-media training packages on Digital Counter and Meter Concepts and Basic Oscilloscope Maintenance Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

100 MHz Dual Trace Oscilloscope

465B44 Oscilloscope/DMM Shown Above Includes DM44 Digital Multimeter.

465B

100 MHz at 5 mV/div

2 ns/div Sweep Rate with X10 Sweep Magnifier

Trigger View

Versatile Trigger Selection

Alternate Sweep

The new 465B offers upgraded performance to match advancements in technology, while providing improved trace quality, easier maintenance, and greater operator flexibility.

Improved trace selection versatility allows you to choose channel 1 and/or channel 2, sum or difference, and A trigger view in any combination.

In addition, the 465B has all the features of the original 465: 5 mV/div vertical sensitivity, dual trace, delayed sweep, the differential time/DMM option, and a sharp, bright 8 x 10 cm CRT.

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth* and Rise Time — (at all deflection factors from 50 Ω terminated source)

−15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, 3.5 ns	85 MHz, 4.1 ns

*Measured at −3 dB. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50 Ω.

Lower −3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

Deflection Factor at BW
5 mV/div to 5 V/div.

1-2-5 sequence, accurate ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. LED warning light indicates uncalibrated setting. In cascade mode sensitivity is approx 1 mV/div.

Display Modes — Ch 1; Ch 2 ADD (normal and inverted), alternate, chopped—approx 500 kHz rate, in any combination electronically switched.

CMRR — Common-mode rejection ratio at least 20 dB at 20 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are indicated by two readout lights behind knob skirts. LEDs are off when channel not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by approx 20 pF.

Max Input Voltage

Dc coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac coupled	250 V (dc + peak ac) 500 V (p-p at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.02 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends max sweep rate to 2 ns/div. LED indicates X10 mag.

Time Base B — 0.02 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends max sweep rate to 2 ns/div. LED indicates X10 mag.

Variable Time Control — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. LED warning light indicates uncalibrated setting.

Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes — A, A intensified, B delayed. B ends A for increased intensity in the delayed mode. Electronic switching between intensified and delayed sweep. A sweep and B sweep may be viewed simultaneously.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s.

Differential Time Measurement Accuracy —

Delay Time Setting	+15°C to +35°C
over one or more major dial divisions	±1%
less than one major dial division	±0.01 major dial divisions

Jitter — 1 part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

TRIGGERING A AND B

A Trigger Modes — Normal (sweep runs when triggered), automatic (sweep runs in the absence of a triggering signal and for signals below 30 Hz), Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). LED lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling —

COUPLING	to 25 MHz	At 100 MHz
Internal Dc	0.3 div deflection	1.5 div deflection
External	50 mV	150 mV
External ÷10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac Lf Reject	Requirements increase below 50 kHz	
Ac Hf Reject	Requirements increase below 60 Hz and above 50 kHz	

Jitter — 0.5 ns or less at 100 MHz and 2 ns/div.

A Trigger View — Electronically switched trigger view displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal which can be displayed simultaneously. The deflection factor is approx 100 mV/div (1 V/div with external ÷10).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

A Sources — Norm, Ch 1, Ch 2, line, external, and external ÷10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

Full-sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

DISPLAY

CRT — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 phosphor standard; P11 optional. 18 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in locating an offscreen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C. Filtered forced air ventilation is provided.

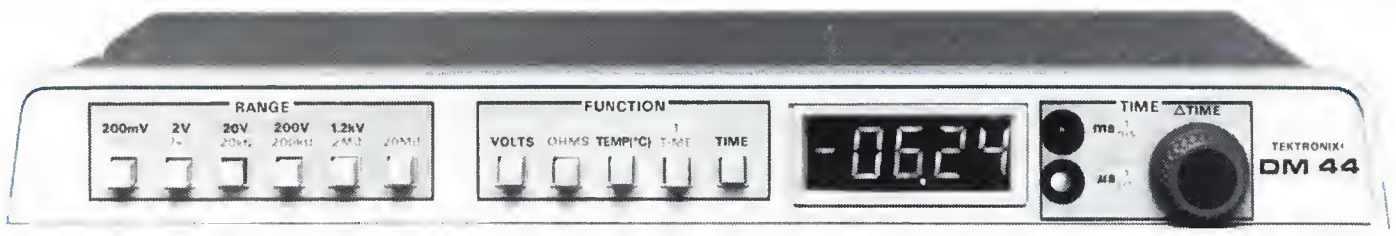
Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10-55 — 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95%-97% relative humidity as specified in MIL-T-28800B (par 3.9.2.2).

Shock — Operating and nonoperating: 30 g's ½ sine, 11 ms duration, 3 shocks per axis in each direction for a total of 18 shocks.

DMM Within a Portable Oscilloscope



OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — Ch 1 vertical signal is dc to at least 50 MHz (−3 dB), and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (approx 5 V).

Power Requirements — Quick-change line voltage selector provides six ranges; 110 V, 115 V, 120 V. 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, 85 watts max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

	Cabinet		Rackmount	
Dimensions	**in**	**cm**	**in**	**cm**
Height	6.2	15.7	7.0	17.7
Width (with handle)	12.9	32.8	19.0	48.3
Depth (with panel cover)	18.1	46.0	18.0	45.7
Depth (handle extended)	20.3	51.6		
Weights (approx)	**lb**	**kg**	**lb**	**kg**
Net (without panel cover)	22.8	10.3	29.4	13.3
Net (with panel cover and accessories)	25.3	11.5		
Shipping	37.0	16.7	58.0	26.3

INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03), blue accessory pouch (016-0535-02), clear pouch (016-0537-00), blue CRT light filter (337-1674-00), clear CRT light filter (337-1674-01), ground wire (134-0016-01), two 1½-amp fuses (159-0016-00), one ¾-amp fuse (159-0042-00). Rack models also include mounting hardware and slide out assemblies, but not pouches.

ORDERING INFORMATION

465B Oscilloscope $2600
R465B Rackmount Oscilloscope $2750
465B44 Oscilloscope/DMM $3045

INSTRUMENT OPTIONS

Option 01, delete temperature probe on 465B44 ..... Sub $85
Option 04, Emc Modification ..... Add $125
Option 05, TV Sync Separator (Provides triggering on TV field and TV line) ..... **Add $210**
Option 07, Ext Dc Operation ..... Add $190
Option 07 cannot be ordered with 465B44.
Option 78, P11 Phosphor $35

Modification kits for field conversion of existing 465Bs, to Option 04, Option 07, or 465B44 scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth*
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz
	Switchable 10X	10 MΩ 14 pF	90 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ 2 pF	100 MHz
	100X Head	10 MΩ 2 pF	100 MHz
	Ac Head	10 MΩ 4 pF	100 MHz
Current Probe	**Calibration**	**Insertion Impedance**	
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz

*Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth.

For information on hoods, covers, filters, carts, battery packs, rack adapter, and cameras, see accessories for 475/475A on page 153.

DM 44 DIFFERENTIAL-TIME/DMM OPTION

1% timing measurements were never this easy! With the DM 44 Option, available on five TEKTRONIX 400 Series Portables, time intervals can be read directly from the 3½ digit LED screen. Simply use the Delay Time control and the Δ time dial to position intensified spots at the beginning and end of the interval you wish to measure(A). Next, switch to delayed sweep and use the Δ time dial to superimpose the end of the interval on the beginning (B). Then read its differential time or frequency from the 3½ digit LED panel (C). It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44-equipped 400 Series Oscilloscope. The DM 44 measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to 150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

The DM 44 is available as a factory installed option on the 464, 465B, 466, 475 and 475A Portables. It adds Delta Delayed Sweep and independent DMM capabilities to these 400 Series Scopes. First, consider your bandwidth, sensitivity, storage, and price requirements. Then specify the DM 44 Option for simple and accurate digital measurements.

DM 44 CHARACTERISTICS

Timing Measurements

Differential Time Delay Accuracy —

+15°C to +35°C	−15°C to +55°C	
used with 464, 465B, 466, 475, and 475A	used with 464, 465B, and 466	used with 475 and 475A
within 1% of reading ±1 count	within 2.5% of reading ±1 count	within 1.5% of reading ±1 count

1/Time Accuracy —

+15°C to +35°C	−15°C to +55°C	
used with 464, 465B, 466, 475, and 475A	used with 464, 465B, and 466	used with 475 and 475A
within 2% of reading ±1 count	within 3.5% of reading ±1 count	within 3% of reading ±1 count

Dc Voltage

Ranges — 0-200 mV, 0-2 V, 0-20 V, 0-200 V, 0-1.2 kV.

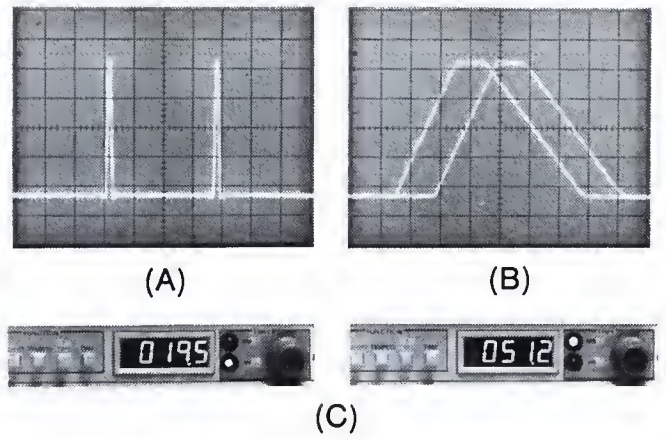
Resolution — 100 μV.

Accuracy — Within 0.1% of reading ±1 count.

Input Resistance — 10 MΩ for all ranges. Removal of an internal strap increases resistance to approximately 1000 MΩ on 200 mV and 2 V ranges.

Normal-Mode Rejection Ratio — At least 60 dB at 50 Hz and 60 Hz.

Common-Mode Rejection Ratio — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.



Recycle Rate — Approximately 3.3 measurements/s.

Response Time — Within 0.5 s.

Maximum Safe Input Voltage — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

Resistance

Ranges — 0-200 Ω, 0-2 kΩ, 0-20 kΩ, 0-200 kΩ, 0-2 MΩ and 0-20 MΩ.

Resolution — 0.1 Ω.

Accuracy —

Range	Accuracy
200 Ω	within 0.25% ±1 count + probe resistance
2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ	within 0.25% ±1 count
20 MΩ	within 0.3% ±1 count

Recycle Rate — Approximately 3.3 measurements/s.

Response Time —

200 Ω through 200 kΩ ranges	within 1 s
2 MΩ ranges 20 MΩ ranges	within 5 s

Maximum Safe Input Voltage — 120 V rms between + and common inputs.

Temperature Using P6430 Probe

Range — −55°C to +150°C

Accuracy —

DM 44 Temp	P6430 Tip Temp	Accuracy: probe calibrated to DM 44	Accuracy: probe not calibrated to DM 44
+15°C to +35°C	−55°C to +150°C	±2°C	±6°C
−15°C to +55°C	−55°C to +125°C	±3°C	±8°C
	+125°C to +150°C	±4°C	±8°C

INCLUDED ACCESSORIES

One pair, Test Leads (003-0120-00), one P6430 Temperature Probe (010-6430-00).

ORDERING INFORMATION

465B DM 44 (Order 465B 44) $3390
475 DM 4 Oscilloscope/DMM $4405
475A DM 44 (Order 475A 44) $4845
466 DM 44 Oscilloscope/DMM $6670
464 DM 44 Oscilloscope/DMM $5610
Option 01 delete temperature probe ..... Sub $75

Modification kits for field conversion of existing 464s, 465s, 466s, 475s, and 475As to DM 44-equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Field Engineer, Distributor, or Representative for information.

100 MHz Dual Trace Tri-Service Standard Oscilloscope

465M (AN/USM) 425 (V 1)

Fully Provisioned through the Federal Supply System

Meets MIL-T-28800, Type II, Class 4, Style C for the Environmental Conditions Listed

100 MHz at 5 mV/div, Dual Trace, Delayed Sweep

Accepted and Specified by All Branches of the Military and by Several Civil Agencies

If you're a contractor involved in designing and specifying systems for the government, here's a 100 MHz oscilloscope that should top your recommended support equipment list—the TEKTRONIX 465M Portable Oscilloscope.

The TEKTRONIX 465M is the AN/USM-425 (v) 1 tri-service standard 100 MHz portable oscilloscope. The instrument is accepted, fully provisioned, and supported throughout the Federal Supply System. Because the MIL manuals and support documentation are already complete, your required paper work is greatly reduced and it's much simpler for the government to accept your recommendations.

You can now order the 465M directly from your Tektronix Field Engineer with the AN/USM 425 (v) 1 nomenclature by simply specifying option 49. This assures the fastest possible delivery of your AN/USM 425 (v) 1.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth and Rise Time—Dc to at least 100 MHz (−3 dB) and rise time 3.5 ns or less for dc coupling and −15°C to +55°C. For ac coupling the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Bandwidth Limit Mode—Bandwidth limited to 20 MHz.

Deflection Factor—5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Dc accuracy: ±2% 0°C to 40°C; ±3% −15°C to 0°C, 40°C to 55°C. Uncalibrated, continuously variable between settings, and to at least 12.5 V/div.

Common-Mode Rejection Ratio—25:1 to 10 MHz; 10:1 from 10 to 50 MHz, 6 cm sinewave. (ADD Mode with Ch 2 inverted.)

Display Modes—Ch 1, Ch 2 (normal or inverted), alternate, chopped (250 kHz rate), added, X-Y.

Input R and C—1 MΩ ±2%, approx 20 pF.

Max Input Voltage—Dc or ac coupled: ±250 V dc + peak ac at 50 kHz, derated above 50 kHz.

Cascaded Operation—(Ch 2 Out into Ch 1), Bandwidth, dc to at least 40 MHz. Sensitivity, approx 1 mV/div when terminated in 50 Ω at Ch 1 Input with both Ch 1 and Ch 2 V/div switches set to 5 mV/div.

HORIZONTAL DEFLECTION

Time Base A—0.5 s/div to 0.05 μs/div in 22 steps (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Time Base B—50 ms/div to 0.05 μs/div in 19 steps (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Accuracy—

	Unmagnified	Magnified
+20°C to +30°C	±2%	±3%
−15°C to +55°C	±3%	±4%

Mixed Sweep Accuracy—A portion—±4%.
B portion—±2%.

Horizontal Display Modes—A, A intensified by B, B delayed by A, and mixed.

CALIBRATED SWEEP DELAY

Calibrated Delay Time—Continuous from 0.1 μs to at least 5 s after the start of the delaying A sweep.

Differential Time Measurement Accuracy—for measurements of two or more major dial divisions:
+15°C to +35°C, 0.1% of full scale
0°C to +55°C, additional 1% allowed.

Jitter—1 part or less in 20,000 (0.005%) of X10 the A TIME/DIV switch setting.

TRIGGERING A AND B

A Trigger Modes—Normal Sweep is triggered by an internal vertical amplifier signal, external signal, or internal power line signal. A bright baseline is provided only in presence of trigger signal. Automatic: A bright baseline is displayed in the absence of input signals. Triggering is the same as normal-mode above 40 Hz. Single (main time base only): The sweep occurs once with the same triggering as normal. The capability to re-arm the sweep and illuminate the reset lamp is provided. The sweep activates when the next trigger is applied for rearming.

A Trigger Holdoff—Increases A sweep holdoff time to at least X10 the TIME/DIV settings, except at 0.2 s and 0.5 s.

Triggering Sensitivity and Coupling—

Coupling		From 30 Hz to 25 MHz	At 100 MHz
Dc	Internal	0.3 div	1.0 div
	External	50 mV	150 mV
Ac	Attenuates signals below		30 Hz
Ac Lf Reject	Attenuates signals below		15 kHz
Ac Hf Reject	Attenuates signals below		50 kHz

Jitter—0.5 ns or less at 100 MHz and 5 ns/div, −15°C to +55°C.

Trigger View—View external and internal trigger signals; Ext 1X, 100 mV/div, Ext ÷10, 1 V/div.

Level and Slope—Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits continuously variable triggering on any level between +1.0 V and −1.0 V on either slope of the trigger signal.

A Sources—Ch 1, Ch 2, NORM (all display modes triggered by the combined waveforms from Ch 1 and 2), LINE, EXT, EXT ÷10.

B Sources—B starts after delay time; Ch 1, Ch 2, NORM, EXT, EXT ÷10.

X-Y OPERATION

Sensitivity—5 mV/div to 5 V/div in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5 V/div.

X Axis Bandwidth—Dc to at least 4 MHz.

Y Axis Bandwidth—Dc to 100 MHz.

X-Y Phase—Less than 3° from dc to 50 kHz.

SIGNAL OUTPUTS

A Gate—Approx 5.0 V positive-going pulse.

B Gate—Approx 5.0 V positive.

DISPLAY

CRT—5 in, rectangular tube; 8 x 10 cm display; P31 Phosphor.

Graticule—Internal, non-parallax; illuminated. 8 x 10 cm markings with horizontal and vertical centerlines further marked in 0.2 cm increments. 10% and 90% markings for rise time measurements.

Graticule Illumination—Provides variable illumination from 0 to greater than optimum illumination.

Beam Finder—Limits the display to within the graticule area and provides a visible display when pushed.

Z-axis Input—A female BNC connector is provided to permit intensity modulation over the dc to 15 MHz range. At optimum intensity, intensity modulation is accomplished with a Z axis input of from −5 V (to intensify) to +5 V (to blank). Continuous operation maximum input shall be ±50 V (dc + peak ac).

ENVIRONMENTAL

EMC—Complies with the following limits as specified in MIL-T-28800B. CE01 (10 kHz to 20 kHz only), CE03, CS01, CS02, CS06, RE01 (relaxed 10 dB at fundamental, third harmonic, and fifth harmonic of the power source frequency), RE02 (limited to 7 GHz), RS01 and RS03 (limited to 1 GHz).

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −62°C to +85°C.

Altitude—Operating: to 15,000 feet. Max operating temperature decreased 1° C/1,000 ft above 5,000 ft Non-operating: to 50,000 ft.

Vibration—Operating: along each of the three major axes:
a. cycling 5 to 25 to 5 Hz for 10 min at 0.025 in p-p;
b. cycling 25 to 55 to 25 Hz for 5 min at 0.020 in p-p;
c. dwelled at 55 Hz for 10 min at 0.020 in p-p.
Total vibration time 75 min.

Humidity—5 cycles (120 hours) referenced to MIL-E-16400F (operating and non-operating).

Shock—Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks each direction per axis for a total of 18 shocks.

OTHER CHARACTERISTICS

Calibrator Output Voltage—1.0 V ±1.0% −15°C to +55°C. Frequency approx 1 kHz.

Channel 2 Signal Output—Through main module Ch 2 OUT connector. Output voltage: approx 50 mV/div into 1 MΩ, approx 25 mV/div into 50 Ω. Output resistance: approx 50 Ω. Bandwidth: dc to at least 40 MHz into 50 Ω.

Power Requirements—100 V to 132 V rms, 200 V to 264 V rms. 48 Hz to 440 Hz. Maximum power consumption 60 watts at 115 V, 60 Hz.

Dimensions	in	cm
Height (with feet)	7.05	17.91
Width (with handle)	13.65	34.67
Width (without handle)	12.50	31.75
Depth (including panel cover)	24.45	54.58
Depth (handle extended)	24.10	61.10
Weight (approx)	**lbs**	**kg**
Net (without cover and accessories)	24.0	10.9
Net (with panel cover, modules, and accessories)	27.0	12.2
Shipping	34.2	15.5

Transportation—Meets the limits of National Safe Transit Committee test procedure 1A with a 30 in drop.

Included Accessories—One accessory and cover assembly (200-2055-01), one 1X probe (010-6101-00), two 10X probes (010-6104-00), three pincer tips (013-0107-03), two UHF male to BNC female adapters (103-0015-00), two BNC male to UHF female adapters (103-0032-00), one T connector (103-0030-00), one BNC male to dual binding post adapter (103-0035-00), three probe tip adapters (103-0051-01), three banana tips (134-0013-00), three 6 in. leads with spring clips (175-0124-01), three hooked probe tips (206-0105-00), one blue filter (337-2122-00), one clear filter (337-2122-01), three miniature alligator clips (344-0046-00), one power cord (161-0118-00).

ORDERING INFORMATION

465M Portable Oscilloscope $3150

Option 49 AN/USM 425 (v)1 . . . . . No Charge

OPTIONAL ACCESSORIES

Probe—P6022 Current Probe, 9 ft cable with termination.
Order 015-0135-01 . . . . . $290

Folding Polarized Viewing Hood
Order 016-0180-00 . . . . . $27

Mesh Filter—Improves contrast and emc filtering.
Order 378-0726-01 . . . . . $33

SCOBE-MOBILE® Cart—Occupies less than 18 in. of aisle space.
Order 200C $235

1105 Battery Power Supply—Provides 1.8 hours of battery operation.
Order 1105 Battery Power Supply $1100

Rack Adapter (Cradle Mount) Kit—Rack height 7 in, depth 18.75 in, width 19 in.
Order 040-0825-01 . . . . . $250

RECOMMENDED CAMERA

C-30 BP Option 01 General Purpose Camera—Includes 016-0301-00 mounting adapter/corrector lens.
Order C-30BP Option 01 Camera $1025

For further information see Camera section.

Tektronix offers maintenance training classes on instruments in the 400 Series and multi-media training packages on Digital Counter and Meter Concepts and Basic Oscilloscope Maintenance Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

50 MHz Dual Trace Oscilloscope

455

50 MHz at 5 mV/div

5 ns/div Sweep Rate with X10 Sweep Magnifier

Trigger View

Dual-Trace, Delayed Sweep

Battery Operation (Optional)

The 455 is extremely easy to operate, thanks to well-laid-out, color-coded controls. This means minimum operator training time, plus easier, faster, more error-free measurements.

The value leading 455 is an economy/performance, general-purpose oscilloscope. Though its price is moderate, it accommodates most measurements required in digital service.

The 455, the 400 Series value leader, is a rugged and economical portable that retains the high performance of the 400 Series.

Special features of the 455 let you check trigger signal presence and timing at the push of a button, without moving the probes. Errors in amplitude readings are minimized through lighted vertical deflection factor readout. 1X and 10X probes are automatically accounted for by the readout. If the 455's modular probes should become damaged, the probe tip, cable or compensation unit can be quickly and inexpensively replaced. A large 8 x 10 cm display permits easy viewing, yet the control area remains uncrowded.

An important 455 option, adding to versatility, is the snap-on 1106 Battery Pack.

Modular design means easy serviceability. Vertical amplifier and time-base modules can be quickly removed for ready access to all components, making repairs faster and less costly.

Calibration time is reduced with the 455. A minimum number of adjustments, made possible by actively trimmed networks, simplifies procedures and saves calibration time.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Rise Time — Bandwidth dc to at least 50 MHz and rise time 7.0 ns or less, at all deflection factors from 50 Ω terminated source. Lower −3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

*Measured at −3 dB.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. In cascade mode sensitivity is approx 1 mV/div. Cascaded bandwidth is at least 20 MHz, when signal out is terminated in 50 Ω.

Display Modes — Ch 1, Ch 2 (normal or inverted), alternate, chopped (250 kHz rate), X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two lighted indicators beside the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2%, approx 20 pF.

Max Input Voltage —

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Variable Time Control — Time Base A, provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy, Full 10 Cm —

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes — A, A intensified by B, B delayed. B ends A for increased intensity in the delayed mode.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

Differential Time Measurement Accuracy —

Delay Time Settings	+15°C to +35°C
Over one or more major dial divisions	1.5%
Less than one major dial division	±0.015 major dial division

Jitter — 1 part or less in 20,000 (0.005%) of X10 the A sweep time/div setting.

TRIGGERING A AND B

A Trigger Modes — Normal Sweep (runs when triggered), single sweep (runs one time on the first triggering event after the single sweep pushbutton is pressed). Automatic (sweep free-runs in the absence of a trigger and for signals below 20 Hz). Lights indicate when single sweep is ready.

A Trigger Hold-off — Adjustable control permits a stable presentation of repetitive complex waveforms.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, following the A sweep delay time, in each of these modes.

Time Base A and B Trigger Sensitivity and Coupling—

Coupling		To 10 MHz	At 50 MHz
Dc	Internal	0.4 div deflection	1.5 div deflection
	External	50 mV	250 mV
	External ÷10	500 mV	2.5 V
Ac	Requirements increase below 60 Hz		
Ac Lf Reject	Requirements increase below 50 kHz		
Ac Hf Reject	Requirements increase below 60 Hz and above 50 kHz		

Jitter — 0.5 ns or less at 50 MHz and 5 ns/div (X10 MAG on).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. Provides quick verification of external trigger and time comparison between external trigger and the displayed signal. Deflection factor approx 50 mV/div (0.5 V/div in external ÷10 mode).

Level and Slope — Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits triggering on any level between −2 V and +2 V (−20 V to +20 V for external ÷10).

A Sources — Norm, Ch 1, Ch 2, line, external, and external ÷10).

B Sources — Starts after delay, norm, Ch 1, Ch 2 and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

Full-sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 3 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

DISPLAY

CRT — 8 x 10 cm display, horizontal and vertical center lines further marked in 0.2 cm increments: P31 Phosphor standard, P11 Phosphor optional. 12 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses the display to within the graticule area and provides a visible display when pushed.

Z-axis Input — Dc coupled, positive-going signal decreases intensity: 5 V p-p signal causes noticeable modulation at normal intensity: dc to 20 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V ±1%. Frequency approx 1 kHz.

Vertical Signal Output — Ch 2 vertical signal is dc to at least 20 MHz and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ.

Gate Outputs — (approx 5 V) internally selectable from either A or B time base.

Power Requirements — Quick change line voltage selector provides two ranges: 100 V to 132 V, 200 V to 264 V, 48 Hz to 440 Hz. Power consumption 35 watts at 115 V, 60 Hz. Operation from 12 V or 24 V dc is available with Option 07.

Dimensions	In	cm
Height (w/o pouch)	7.1	17.9
Width (with handle)	13.7	34.7
Depth (with panel cover)	19.5	49.5
Depth (handle extended)	21.7	55.2
Weight (approx)	**lb**	**kg**
Net (without panel cover)	24.0	10.9
Net (with panel cover and accessories)	27.0	12.2
Shipping	34.2	15.5

INCLUDED ACCESSORIES

Two P6105 Probes (010-6105-03), blue accessory pouch (016-0339-00) clear pouch (016-0537-00), clear CRT filter (337-2122-01), adapter (134-0016-01) ½-A fuses (159-0025-00), two 2-A fuses (159-0021-00), one 1-A fuse (159-0022-00).

ORDERING INFORMATION

455/A2/B2 Portable Oscilloscope . . . $2450

INSTRUMENT OPTIONS

Option 04 **Emc Modification** . . . . . **Add $135**
Option 05 **TV Sync Separator** (provides triggering on TV field) . . . . . **Add $250**
Option 07 **External Dc Operation** . . . . . **Add $210**
Option 78 **P11 Phosphor** . . . . . **Add $35**

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 455
P6062B 6 ft	1X	1 MΩ 105 pF	6.7 MHz
	Switchable 10X	10 MΩ 14 pF	50 MHz
P6202	10X	10 MΩ 2 pF	50 MHz
FET probe	100X Head	10 MΩ 2 pF	
2 meter	Ac Head	10 MΩ 4 pF	

*Bandwidths are measured at the upper −3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Current Probe	Calibration	Insertion Impedance	Bandwidth with 455
P6022	10 mA/mV 1 mA/mV	0.03 Ω @ 1 MHz increasing to 0.2 Ω @ 120 MHz	47 MHz

1106 Battery Pack (used with Option 07) . . . . **Add $850**

Rack Adapter (Cradle Mount) Kit — Includes hardware for converting standard 455 to 19 in. rack installation. Cradle mount consists of a shelf and a mask to fit over regular instrument panel. Instrument can be slid out from rack. Rack height 7 in, depth 18¾ in, width 19 in.
Order 040-0825-01 . . . . . **$250**

Protective Cover — Waterproof, blue vinyl.
Order 016-0344-00 . . . . . **$18**

Folding Viewing Hood — Polarized
Order 016-0180-00 . . . . . **$27**

Folding Viewing Hood — Binocular
Order 016-0566-00 . . . . . **$15**

SCOPE-MOBILE® Cart—Occupies less than 18 inches of aisle space.
Order 200C **$235**

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Camera — Includes 016-0301-01 mounting adapter/corrector lens.

Order C-30BP Option 01 . . . . . **$1025**
For further information see Camera section.

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Battery Packs

1105 BATTERY POWER SUPPLY

The 1105 is a rugged, portable power supply suitable for powering virtually any portable oscilloscope in the field. The 1105 is not recommended for the T912.

Frequency — Square wave, 60 Hz ±10%.

Amplitude — Approx 108 V peak, operating from 24 V dc external or 22 V internal charge. Approx 137.5 V peak, operating from 28 V dc external or 30 V internal charge.

Amplitude (Option 01) — Approx 216 V peak, from 24 V dc external or 22 V internal charge. Approx 275 V peak, operating from 30 V dc external or 28 V internal charge.

Charging Power Source — 100 to 132 V ac, 48 to 440 Hz (or internal connections expand range). Option 01 — 200 to 264 V ac, 48 to 440 Hz (or internal connections expand range).

Battery Operating Time — Approx 100 VA hours.

Recommended Max Output Current — 0.9 amp.

Weight — 19.5 lb (8.8 kg).

Order 1105 Battery Power Supply . . . $1100

Option 01, 230 V Operation . . . . . No Charge

1106 BATTERY PACK

The 1106 is a convenient, snap-on battery power supply for TEKTRONIX 455, 464, 465B, 466, 475 or 475A Oscilloscopes when the scope is ordered with Option 07.

Output Power — 22 to 26 V dc; 100 watt-hours from full charge.

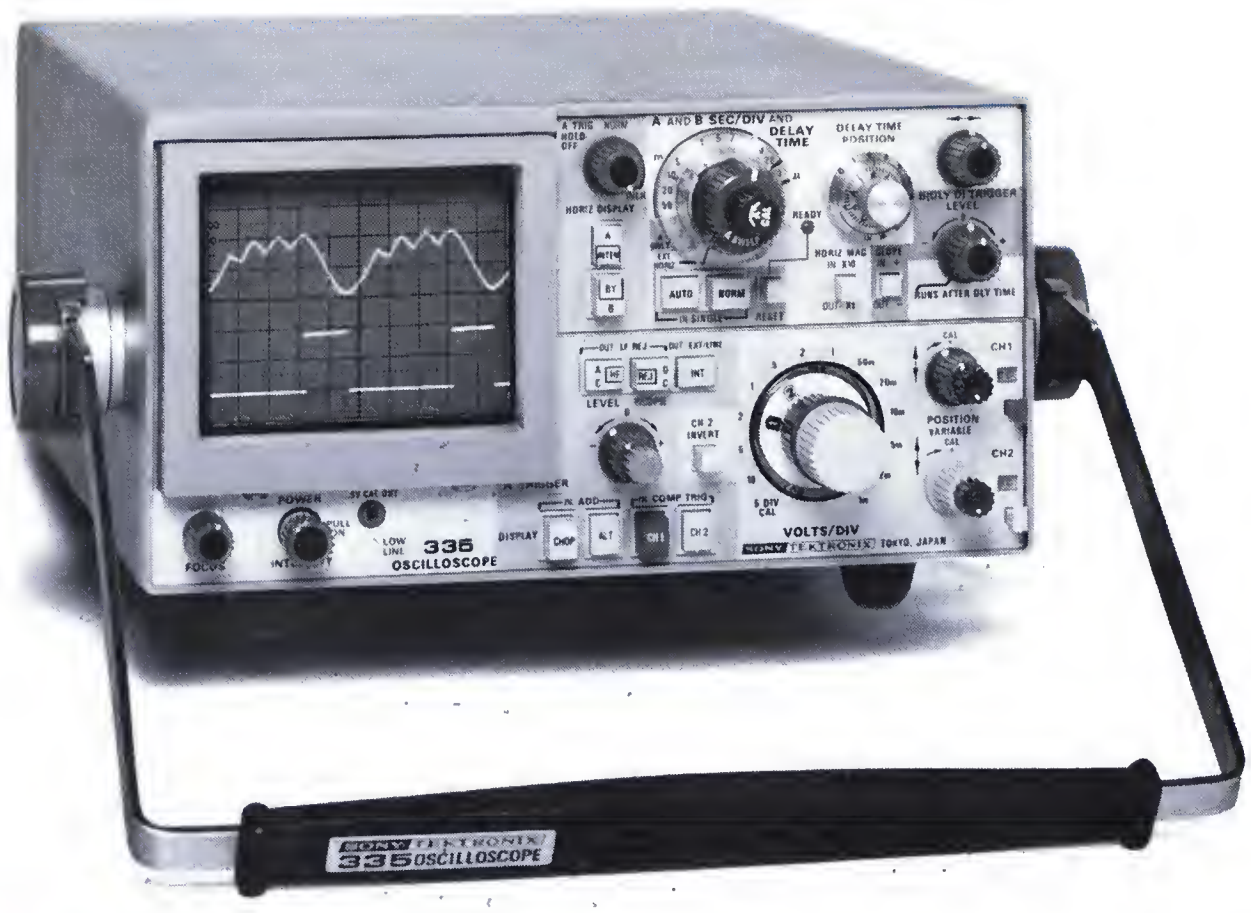
Charging Power Source — 90 to 132 V ac, 50 to 400 Hz; or 180 to 264 V ac, 50 to 400 Hz.

Charging Time — 14 to 16 hours.

Weight — 16 lb (7.2 kg).

Order 1106 Battery Pack $850

35 MHz Dual Trace Oscilloscope



335

35 MHz at 10 mV/Div

Small Size, Weighs ≈10.5

1 mV/div Vertical Sensitivity at 25 MHz

Delay Lines Input

Rugged Construction

The portability of the 335 is a big plus in many digital and analog trouble-shooting applications. And it weighs only 10.5 pounds.

1 mV/div (at 25 MHz) vertical sensitivity insures that low level signals from magnetic recording heads, optical read heads, or industrial control transducers can be accurately and easily measured. Delay lines at the inputs let you view the leading edge of the triggering signal. By using a composite of channels 1 and 2 as a trigger source, stable displays of non-time-related signals can be obtained.

Operation from either ac (90 to 132 V, or 180 to 264 V, 48 to 440 Hz) or dc (+11 to +14 V or +22 to +28 V) assures that power can be obtained at nearly any location.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth and Rise Time — Dc to at least 35 MHz, rise time 10 ns or less. For 1 mV/div to 5 mV/div bandwidth is at least 25 MHz, rise time 14 ns or less. For ac coupling, the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence) accurate ±3%. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — Ch 1, Ch 2 (normal or inverted) alternate, chopped (approximately 300 kHz rate) added, X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Input R and C — 1 MΩ ±2% paralleled by approx 24 pF.

Max Input Voltage, ac or dc coupled, 300 V (dc + peak ac). 300 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.2 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Time Base B — 0.2 μs/div to 50 ms/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Variable Time Control — Time Base A provides uncalibrated, continuously variable sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated settings.

Time Base A and B Accuracy, center 8 div —

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

Horizontal Display Modes — A only. A intensified by B, B delayed by A, B triggerable after A.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuously variable from 1 μs to at least 5 s after the start of the delaying (A) sweep.

Differential Time Measurement Accuracy —

Delay Time Settings between 1.0 and 9.0	+15°C to +35°C
one or more major dial divisions	±2%
less than one major dial divisions	±0.02%

Jitter — 1 Part or less in 20,000 (0.005%) of X10 the A time/div setting.

TRIGGERING A AND B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs once on the first trigger signal after the reset button is pushed).

Variable Trigger Holdoff — For the A sweep an adjustable holdoff control permits a stable display of complex waveforms. Sweep holdoff time can be increased at least X10.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once in each of these modes, following the A sweep delay time.

Trigger Sensitivity and Coupling —

Coupling		To 10 MHz	At 35 MHz
Dc	Internal	0.35 div	1.5 div
	External	70 mV	250 mV
	Ext ÷10	700 mV	2.5 V
Ac	above requirements increase below 60 Hz		
Ac Hf Rej	requirements increase above 20 kHz		
Ac Lf Rej	requirements increase below 40 kHz		

Trigger Sources — Internal Ch 1, internal Ch 2, internal composite (uses a composite of Ch 1 and Ch 2 signals to produce trigger), external, external ÷10, and line. The B sweep can also be started automatically at the end of the time base A delay.

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both Ch 1 and Ch 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-axis Deflection Factors — Variable from approx 20 mV/div to approx 20 V/div. Dc to at least 500 kHz.

Input Impedance — Approx 1 MΩ paralleled by 24 pF.

DISPLAY

CRT — 8 x 10 div (0.6 cm/div) display. P31 Phosphor. 12 kV accelerating potential.

Graticule — Internal (non-parallax) non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm.

Z-axis Input — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 600 kHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Non-operating: −40°C to +75°C.

Altitude — Operating: to 15,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: to 50,000 ft max.

Vibration — Operating and nonoperating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Humidity — 5 cycles (120 hours) referenced to MIL-E-16400 F.

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V (±1%) approx 1 kHz from 20°C to 30°C.

Power Source — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a max current drain of 2 A at +12 V or 1.0 A at +24 V.

Dimensions	In	cm
Height	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	13.6	34.7
Depth (handle extended)	17.6	44.8
Weights (approx)	**lb**	**kg**
Net (without accessories)	10.5	4.7
Shipping	17.0	7.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case and pouch (016-0485-00), external dc cable assembly (012-0406-00), strap assembly (346-0131-00), two 1-A fuses (159-0064-00), two 0.4-A fuses (159-0139-00), two 2-A fuses (159-0107-00), three 0.2-A fuses (159-0080-00).

ORDERING INFORMATION

335 Portable Oscilloscope $2565

OPTIONAL ACCESSORIES

Viewing Hood — Order 016-0297-00 ..... $6.50

CRT Filter — Light blue. **Order 378-2016-01 .... $1.80**

CRT Filter — Light amber. **Order 378-0843-01 .. $1.80**

CRT Mesh Filter — With frame and holder.
Order 378-0063-00 ..... $27

The SONY®/TEKTRONIX® 335 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 335 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

RECOMMENDED CAMERA

C-30BP General Purpose Camera $1050

Camera Adapter — mounts C-30B to 335.
Order 016-0327-01 ..... $150

For further information see Camera section.

Battery Powered 5 MHz Oscilloscope/DMM

305

5 MHz at 5 mV/div — **Full X-Y**

Dual-Trace — **Weighs ≈10.6 lb.**

The 305 Oscilloscope/DMM is the ideal oscilloscope for those who demand portability and multi-function versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5 MHz oscilloscope with an integral auto ranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5 MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb. (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

VERTICAL DEFLECTION

Bandwidth — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is 10 Hz approx.

Deflection Factor — 5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — Ch 1, Ch 2, Chopped, Alternate, Added, Invert Ch 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.

Input R & C — 1 MΩ ±2%, paralleled by 47 pF approx.

Max Input Voltage — ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p ac at <1 kHz.

HORIZONTAL DEFLECTION

Time Base — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 mag extends sweep rate to 0.1 μs/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

Time Base Accuracy, center 8 div —

	0°C to +40°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

(excludes first 10 div and all sweep past 90 in X10 mag).

TRIGGER

Modes — Normal and Auto (p-p).

TTL Triggering — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V and 0.2 V/div or external trigger signals.

Trigger Sources — Internal Ch 1, internal Ch 2, external. Threshold voltage, int (with 10X probe) 1.4 V within ±0.3 V, Ext (with 10X probe) 1.4 V within ±0.2 V.

Trigger Sensitivity In NORMAL-Mode

Coupling	Mode	To 0.5 MHz	At 5 MHz
Dc	Internal	0.3 div.	0.75 div
	External	15 mV	50 mV
Ac	Above requirements increase below 60 Hz		

P-P Auto Operation Sensitivity

Coupling	Mode	500 Hz to 0.5 MHz	0.5 MHz to 5 MHz
Dc, Ac	Internal	0.5 div	1.0 div
	External	35 mV	70 mV

External Trigger — Max Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C, approx 1 MΩ paralleled by approx 47 pF.

X-Y OPERATION

Input — X-axis input is via the Ch 1 connector; Y-axis input is via the Ch 2 connector.

X-Y Characteristics — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.

X-Axis Bandwidth is dc to 150 kHz.

DISPLAY

CRT — 8 x 10 div (0.632 cm/div) display. P31 Phosphor. 2 kV accelerating potential.

Graticule — Internal, non-illuminated.

DMM

DC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 1000 V (autoranging).

Accuracy — Within 0.1% of reading, ±2 counts.

Common-Mode Rejection — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.

Response — <1 sec plus range step time (<1 sec/step).

Input R — 100 MΩ ±2%.

AC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 700 V, (autoranging).

Accuracy — Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.

Response Time — <5 sec plus range step time (<1 sec/step).

Input Impedance — 10 MΩ paralled by ≃70 pF.

RESISTANCE

Ranges — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.

Accuracy — Within 0.6% of reading ±3 counts.

Response Time — <5 sec plus range step time (<1 sec/step). Max safe input voltage at DMM input Connectors—DCV: 1000 V dc + peak ac, between HI and LO inputs or between HI and chassis.

ACV — 700 V rms if sinusoidal between HI and LO inputs or between HI and chassis, +1000 V dc + peak ac between HI and LO inputs or between HI and chassis, +500 V (dc component) between LO and chassis. kΩ function settling: 100 V (dc + peak ac) between HI and LO inputs.

All Ranges: 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM), non-operating: −25°C to +75°C.

Altitude — Operating: to 30,000 feet max, decrease max temperature by 1°C/1000 feet from 5,000 feet to 30,000 feet. Non-operating: 50,000 feet max.

Vibration — 15 min along each of the three major axes, 0.025 in (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 min cycles.

Humidity — Non-operating: 5 cycles (120 hrs) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.

Shock — Operating and non-operating: 30 g's, ½ sine, 11 ms duration. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V accurate ±1% from 20°C to 30°C ±2% from −15°C to 55°C.

Power Sources — External ac source, 90 V to 132 V or 180 V to 250 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation of 17 W. External dc source +9 V to +32 V.

Charge Time: at least 16 hours for full charge.

Operating Time — Internal NiCd batteries provide ≃1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or 2 hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

Dimensions	In	cm
Height	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	14.6	37.1
Depth (handle extended	18.0	45.8
Weights (approx.)	**lb**	**kg**
Net (without accessories)	10.6	4.8
Shipping	17.1	7.8

INCLUDED ACCESSORIES

Two 10X probes (010-6149-03), one DMM probe package (012-0732-00), one carrying case (016-0401-00), one carrying case cover (200-2260-00), one carrying strap assembly (346-0131-00), one clear CRT filter (331-0394-01), one blue CRT filter (378-2016-01), one external dc cable assembly (012-0406-00).

ORDERING INFORMATION

305 DMM/Oscilloscope $2020

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Viewing hood **(016-0297-00)** **$6.50**
BNC to binding post adapter **(103-0033-00)** **$4.75**

RECOMMENDED CAMERA

C-30BP General Purpose Camera **$1050**
Camera Adapter Mount C-30B to 335
Order 016-0327-01 ..... **$150**
For further information see Camera section.

5 MHz Oscilloscope

221

5 MHz, 5 mV/div to 100 V/div

0.1 μs/div Sweep Rate with X10 Sweep Magnifier

Internal Battery Pack

Integral 1 MΩ probe

Weighs ≈3.5 lb

The 221 Miniscope weighs just 3.5 pounds and easily fits into a tool box or brief case; it measures only 3 x 5.25 x 9.5 inches. Yet it has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least three hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 to 250 V, 48 to 62 Hz ac, or 80 to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series Miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

VERTICAL DEFLECTION

Bandwidth — Dc to 5 MHz (−3 dB point) at all calibrated deflection factors. Lower −3 dB point ac coupled is approx 2 Hz.

Deflection Factor — 5 mV/div to 100 V/div, accurate ±3% from 0°C to +40°C and ±5% from −15°C to 0°C and +40°C to 55°C. Uncalibrated, continuously variable between steps to at least 300 V/div.

Input R and C — Approx 1 MΩ paralleled by approx 29 pF via attached signal acquisition probe.

Max Input Voltage — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 200 ms/div, accurate ±3%.

Magnifier — Increases all sweep speeds X10 with a max sweep speed of 0.1 μs/div.

Variable Time Control — Extends minimum sweep rate to approx 0.5 s/div. Continuously variable between calibrated settings.

TRIGGER

Modes — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity

Mode	To 1 MHz	At 5 MHz
Internal	0.5 div	1 div
External	0.5 V	1 V

X-Y OPERATION

Input — X-axis input is via the external trigger or the external horizontal input.

X-axis Deflection Factor — 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

Max External Horizontal Input Voltage — 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

Input Impedance — Approx 0.5 MΩ paralleled by approx 30 pF.

DISPLAY

CRT — 6 x 10 div (0.5 cm/div) display. P31 Phosphor normally supplied; P7 optional without extra charge. 1 kV accelerating potential.

Graticule — Internal, black line, non-illuminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only), −15°C to +55°C. Charging or operating from ac line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one minute cycles. Held for 3 min at 55 Hz.

Humidity — 5 days at +50°C, 95% humidity.

Shock — Operating and nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide at least 2 hours operation at max trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx. 16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge. External power source, 90 to 250 V ac (48 to 62 Hz) or 80 to 250 V dc, 5 W or less.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V rms; or 1.4 x line + (dc + peak ac) not to exceed 350 V.

Dimensions	in	cm
Height	3.0	7.6
Width	5.2	13.3
Depth	9.0	22.8
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.5	1.6
Shipping	≈8.0	≈3.6

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), neck strap (346-0104-00), two spare fuses (159-0080-00).

ORDERING INFORMATION

221 Oscilloscope, including batteries and probe $1495

INSTRUMENT OPTION

Option 76 P7 Phosphor $35

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $16

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $8.00

Probe-tip to BNC Cable Adapter,
Order 103-0096-00 ..... $9.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $7.00

1 MHz Oscilloscope/DMM

213

1 MHz at 20 mV/div

0.4 μs/div Sweep Rate with X10 Sweep Magnifier

DMM and Miniscope in One Unit

Rugged Construction

Internal Battery

Compact, Weighs ≈ 3.7 lb

True Rms Voltage and Current Measurements

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and lightweight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the light-weight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

VERTICAL DEFLECTION (VOLTAGE)

Bandwidth — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is approx 1 Hz.

Deflection Factor — 5 mV/div to 100 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 V/div.

Input R and C — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Max Input Voltage

Input Condition	Max Input Voltage
Dc coupled, 5 mV/div to 1 V/div	500 V (dc + peak ac) at 1 MHz or less
Ac coupled, 5 mV/div to 1 V/div	800 V (dc + peak ac) 500 V peak ac component
Ac, Dc coupled, 2 V/div to 100 V/div	800 V (dc + peak ac) at 1 MHz or less

VERTICAL DEFLECTION (CURRENT)

Bandwidth — Dc to at least 400 kHz (−3 dB point) for 20 μA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (−3 dB point) for 5 μA/div and 10 μA/div.

Deflection Factor — 5 μA/div to 100 mA/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 mA/div.

Max Input Current — 2 A rms or 3 A peak for any range (fuse and diode protection).

HORIZONTAL DEFLECTION

Time Base — 2 μs/div to 500 ms/div (1-2-5 sequence), accurate ±5%.

Variable Magnifier — Increases all sweep speeds to at least X5 with a max sweep speed of 0.4 μs/div.

TRIGGER

Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).

Trigger Sensitivity and Coupling — Ac Internal, (auto and normal, 1 MHz) 0.5 div Dc External, 1 MHz, 1 V.

DISPLAY

CRT — 6 x 10 div (0.52 cm/div) display. P43 Phosphor is standard.

Graticule — Internal, black line, non-illuminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only). −15°C to +55°C. Charging or operating from ac line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: to 25,000 ft, decrease max temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 40,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 40°C or less, 80% or less relative humidity.

Shock — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide approx 3.5 hours operation at max trace intensity for a charging and operating temperature between 20°C and 30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. External power source, 90 to 136 V ac (48 to 62 Hz). Option 01 allows operation from an external 180 to 250 V ac (48 to 62 Hz) or dc supply. Power consumption, 8 watts or less.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms or 1.4 X line + (dc + peak ac) not to exceed 350 V.

Dimensions	In	cm
Height	3.0	7.6
Width	5.2	13.2
Depth	8.9	22.6
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.7	1.7
Shipping	8.6	3.9

DMM

Provides true rms readings of voltage and current.

DC AND AC VOLTAGE

Range — 0.1 V to 1000 V full scale in 5 ranges.

Resolution — 100 μV at 0.1 V full scale.

Accuracy In Dc Mode — For 25°C ±5°C.

Range (Full Scale)

0.1 V	±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading + 0.04% of full scale) per °C.
1 V	±0.1% of reading ±1 count. Temp coef is (±0.01% of reading + 0.01% of full scale) per °C.
10 V and 100 V	±0.15% of reading ±1 count. Temp coef is (±0.015% of reading + 0.01% of full scale) per °C.
1000 V	±0.2% of reading ±1 count. Temp coef is (±0.02% of reading + 0.01% of full scale) per °C.

Accuracy In Rms Mode — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale) per °C.

Range	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1 V, 10 V, and 100 V	2%	1%	1%
1000 V	2%	1%	2%

*Accuracy limit increases linearly for crest factor greater than 2 up to twice indicated limit for crest factor of 5.

Input Resistance — 10 MΩ

Input Capacitance — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.

Setting Time — Dc: 1.5 sec to 0.1% of reading. Rms: 2 sec to 1% of reading.

Max Input Voltage —

Dc Coupled	
0.1 V to 10 V	100 V to 1000 V
500 V (dc + peak ac)	800 V (dc + peak ac)
Ac Coupled	
0.1 V to 10 V	
800 V (dc + peak ac)	

DC AND AC CURRENT

Range — 0.1 mA to 1000 mA full scale in 5 ranges.

Resolution — 100 nA at 0.1 mA full scale.

Accuracy In Dc Mode — For 25°C ±5°C.

Temperature Coef — (±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.

Accuracy In Ac Mode —

Range	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 mA to 1000 mA	2.5%	1.5%	3.5%

*Accuracy limit increases linearly for crest factor greater than 2 up to twice the indicated limit for crest factor of 5.

Settling Time — 1.5 sec to 0.1% of reading.

Max Input Current — 2 A rms or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges — 1 kΩ to 10 MΩ full scale in 5 ranges.

Resolution — 1 Ω on 1 kΩ scale.

Accuracy — For 25°C ±5°C.

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 kΩ to 1 MΩ	0.5% ±1 count
10 MΩ	1% ±1 count

Settling Time — 2 seconds ±2 counts.

READOUT

Number of Digits — 3½ digits plus decimal point and sign.

Display Size — 1 cm high by 4 cm wide (5 characters).

Overrange Capability — At least 200% of full scale.

Overrange Indication — Readout displays scrambled characters.

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), 2 test leads (alligator clip to banana jack) (red 012-0015-00) (black 012-0014-00), neck strap (346-0104-00), 2 power line fuses (159-0080-00), power line plug adapter (option 01 only) (161-0077-01), identification tag (334-2614-00), identification tag (000-7983-00).

ORDERING INFORMATION

213 Miniscope/DMM including batteries and probe $1925

POWER OPTION

Option 01, 180 to 250 V ac (48 to 62 Hz) or dc (Includes batteries and probe) ..... No Charge

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $16

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $8.00

Probe tip to BNC Cable Adapter,
Order 103-0096-00 ..... $9.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $7.00

500 kHz Dual Trace Oscilloscope

212

500 kHz, 1 mV/div to 50 V/div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈3.5 lb

The 212 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches).

Built of impact-resistant plastic and fully self-contained, this miniature portable is perfect for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument — you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

VERTICAL DEFLECTION

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is less than 2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

Display Modes — Ch 1 only, Ch 2 only, or Ch 1 and Ch 2 chopped (approx chop rate −50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — Approx 1 MΩ paralleled by approx 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Max Input Voltage (1X probe only)

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz.
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac 5 MHz or less

HORIZONTAL DEFLECTION

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a max sweep speed of 1 μs/div.

External Horizontal Input — (Ch 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz less than 3°. Input characteristics same as Ch 1.

Max External Horizontal Input Voltage — 50 V (dc + peak ac), 100 V (p-p).

Input Impedance — R and C, 1 MΩ paralleled by approx 30 pF.

TRIGGER

Trigger Modes — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

Coupling		to 500 Hz
Dc	Internal (w/composite trigger source)	0.2 div
	Internal (w/ch 2 trigger source)	0.2 div
	External	1 V to 20 V p-p

DISPLAY

CRT — 6 x 10 div (0.52 cm/div) display. P31 Phosphor.

Graticule — Internal, black line, non-illuminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only), −15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles. Held for three minutes at 55 Hz.

Humidity — 5 cycles (120 hours). 95% relative humidity, referenced to MIL-E-16400F.

Shock — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide approx 5 hours operation at max trace intensity for a charging and operating temperature between 20°C and 30°C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 10 min of operating time remaining in the batteries.

External Ac Source — 110 to 126 V, 58 to 62 Hz, 3 W Can be operated at 104 to 110 V with resulting slow discharge of internal batteries.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms; or 1.4X line + (dc + peak ac) not to exceed 350 V.

Dimensions	In	cm
Height	3.0	7.6
Width	5.3	13.3
Depth	9.5	24.1
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.5	1.6
Shipping	7.0	3.2

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), two 4-A fuses (159-0121-00), identification tags (000-7983-00), identification tag (334-2614-00), carrying strap (346-0104-00).

ORDERING INFORMATION

212 Dual-Trace Oscilloscope, including batteries $1475

POWER OPTIONS

Option 01 for 220-250 V, (48 to 52 Hz) Includes batteries ..... No Charge

Option 02 for 90 to 110 V, includes batteries ..... No Charge

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, approx 20 pF) and higher max input voltage 1000 V (dc + peak ac) Includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adapter (206-0203-00).
Order 010-0378-01 ..... $45

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $16

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $8

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... $9.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $7

Portable Storage Scopes

434

25 MHz at 10 mV/div

20 ns/div Sweep Rate with X50 Sweep Magnifier

Weighs ≈ 20.75 lb

A bistable, split-screen storage oscilloscope with a 25 MHz bandwidth, the compact 434 fills many needs.

The split screen provides: full-screen storage, or upper or lower screen storage, with the other half conventional.

Tektronix 434s are used for maintaining display boards, video monitors, automatic baggage handling systems, X-ray systems and air-conditioning and heating systems.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth and Rise Time — (from 50 Ω terminated source, with or without 10X probe) Dc to at least 25 MHz at 3 dB down*, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low frequency 3 dB down point with ac coupling is 14 Hz or less (less than 1 Hz with 10X probe).

Deflection Factor — 1 mV/div to 10 V/div, accurate ±3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes — Ch 1 only, Ch 2 only (normal or inverted), alternate, chopped (approx 100 kHz), added.

CMRR — Common-mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are indicated by lights besides the knob skirts. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by ≈24 pF.

Max Input Voltage — Dc coupled: 250 V (dc + peak ac); ac coupled: 500 V (dc + peak ac). In either mode the max ac is 500 V p-p at 1 kHz or less.

Delay Line — Permits viewing of leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base — 0.2 μs/div to 5 s/div (1-2-5 sequence). X50 mag extends fastest sweep rate to 20 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to 12.5 s/div.

Time Base Accuracy, Full 10 div —

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±4%	±5%

*Bandwidth derated to 22 MHz above +30C°C.

External Horizontal Input — Deflection factor is approx 0.5 V/div. Input resistance is approx 50 kΩ.

TRIGGER

Modes — Auto trigger (sweep free-runs in absence of triggering signal, normal trigger, single sweep.

Trigger Sensitivity and Coupling —

Coupling		To 5 MHz	At 25 MHz
Dc	Internal	0.3 div deflection	1 div deflection
	External	50 mV	125 mV
Ac	Requirements increase below 20 Hz		
Ac Lf Reject	Requirements increase below 50 kHz		
Ac Hf Reject	Requirements increase above 50 kHz		

Sources — Ch 1 only, composite line, external and external ÷10. External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

External Inputs — Input R approx 1 MΩ paralleled by 100 pF ÷1 or 70 pF ÷10. 250 V (dc + peak ac).

DISPLAY

CRT — 8 x 10 div (1 div = 0.975 cm) horizontal and vertical divisions further marked in 0.2 div increments. P1 Phosphor. 4 kV accelerating potential.

Graticule — Internal, non parallax; nonilluminated.

Beam Finder — Compresses trace to within graticule area for ease in locating an off-screen signal.

Z-axis Input — Dc coupled, positive going signal decreases intensity, 5 V p-p signal causes noticeable modulation; dc to 20 MHz usable frequency range.

STORAGE FEATURES

Display Modes — Split-screen with storage on upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display. Independent operation of halves.

Stored Writing Speed (Center 8 div) — Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 01, 500 div/ms, normal; to 5000 div/ms, enhanced).

Erase Time — 300 ms or less.

Locate — Beam can be positioned left of the graticule area to determine vertical position of next sweep without disturbing stored display.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

25 MHz Dual Trace

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.6 V ±1.0%, 1 kHz ±1.0% (+20°C to +30°C). Output resistance is 575 Ω.

Power Requirements — Operates on all voltages from 90 V to 136 V and 180 V to 272 V, 48 to 440 Hz, 60 W max. Also operates from 220 V dc to 350 V dc.

	Cabinet		Rackmount	
Dimensions	**In**	**cm**	**in**	**cm**
Height (w/o pouch)	5.6	14.2	5.3	13.3
Width (with handle)	13.0	33.0	19.0	48.3
Depth	18.7	47.5	18.0	45.7
Weights (approx)	**lb**	**kg**	**lb**	**kg**
Net	20.8	9.4	23.1	10.5
Shipping	30.0	13.6	49.0	22.2

INCLUDED ACCESSORIES

Two P6105 Probes (010-6105-03), accessory pouch (016-0165-00). Rack models also include mounting hardware and slide out assemblies, but not pouch.

ORDERING INFORMATION

434 Storage Oscilloscope $4150

R434 Storage Oscilloscope Rackmount Model $4310

INSTRUMENT OPTIONS

Option 01 Increased Writing Speed ..... Add $200

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 434
P6062A 6 ft	Switchable 1X	1 MΩ 5 pF	6.7 MHz
	10X	10 MΩ 14 pF	25 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 434**
P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz increasing to 0.2 Ω @ 120 MHz	25 MHz

*Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth.

1105 Battery Power Supply — Operates 1.8 hours. battery operation.
Order 1105 Battery Power Supply $1100

Mesh Filter — Improves contrast and emc filtering.
Order 378-0682-00 ..... $33

Portable to Rackmount Assembly — Includes hardware for standard 434 in 19 inch rack mounting.
Order 016-0272-00 ..... $200

Folding Polarized Viewing Hood —
Order 016-0180-00 ..... $27

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.
Order 200C $235

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Camera — Includes 016-0301-00 mounting adapter/corrector lens.
Order C-30BP Option 01 ..... $1075

For further information see Camera section.

10 MHz Dual Trace Digital Storage Oscilloscope

NEW 468

- 10 MHz Useful Storage Bandwidth
- Cursors for Time and Voltage Measurements
- Envelope Mode
- Signal Averaging and GPIB Options
- 100 MHz Non-Storage Bandwidth

GPIB Product

The 468 is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk.

Advancing the state-of-the-art in digital storage oscilloscopes is the new TEKTRONIX 468. This high performance portable scope is capable of accurately storing and displaying 10 MHz single shot events using a unique display interpolation system.

The 468 was designed with many features which enhance its usefulness in your applications. Cursors and a calibrated LED readout enable you to measure time or voltage differences easily and accurately.

The ENVELOPE mode, a Tektronix exclusive, uses multiple sampling rates and digital memory to capture and record the maximum and minimum excursions of a waveform. The resulting waveform "envelope" can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Unlimited storage time, expandable, repositionable stored traces; SAVE REFERENCE memory; pretrigger viewing; and correction for the trigger uncertainty inherent in digital storage make the 468 the most versatile digital storage scope available today.

In addition, the 468 features all the non-storage performance of our 465B, the industry standard 100 MHz oscilloscope.

Options include signal averaging, a GPIB interface, and a TV sync separator, and emi shielding.

DIGITIZER, MEMORY

Speed — Digitizing rates from 10 samples per second at 5 sec/div to 25 megasamples per second at 2 μs/div and faster. Digitizing rate changes proportionate to sweep speed (50 data words per horizontal division). Chopped mode effectively halves the digitizing rate per waveform.

Resolution — 8 bit (1 part in 256) vertical resolution.

Memory Size — Up to two 512 word waveforms or four 256 word waveforms can be stored and displayed.

Interpolator — Two firmware interpolators; one optimized for sine waveforms, one optimized for pulse waveforms.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth and Rise Time — (at all deflection factors from 50 Ω terminated source)

Storage Modes*

Display Response	Bandwidth	Risetime
Sine	10 MHz	NA
Pulse	2.5 MHz	64 ns

*Bandwidth measured at 5% envelope error and maximum sampling rate, using appropriate interpolator. Rise time is 1.6 times minimum sample interval. Chopped mode halves the bandwidth.

Non-Store Mode**

−15° to +40°C	+45° C to +55° C
DC to 100 MHz, 3.5 ns	85 MHz, 4.1 ns

**Measured at −3 dB. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50 Ω.

Lower −3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

Deflection Factor at Bandwidth

0.5 mV/div to 5 V/div in storage modes
5 mV/div to 5 V/div in non-store
1-2-5 sequence, accurate ±3%

Uncalibrated, continuously variable between steps and to at least 12.5 V/div. In cascade mode sensitivity is approx 1 mV/div. Stored images can be expanded by factor of 10 vertically.

Display Modes — Ch 1; Ch 2 ADD (normal and inverted), Trigger View (non-store only), alternate, chopped — approx 250 kHz rate, in any combination electronically switched in non-store; in storage chop rate is 1/2 the digitizing rate.

Envelope Mode — Records waveform envelope over multiple sweeps. 5 MHz digitizing rate from 5 sec/div to 10 μs/div; 10 MHz digitizing at 5 μs/div; 25 MHz digitizing from 2 μs/div and faster. Number of sweeps equals 1 to 256 plus continuous setting.

CMRR — Common-mode rejection ratio at least 20 dB at 20 MHz (10 MHz in storage) for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All LEDs are off when the channel is not displayed.

Ground Reference Display — In storage modes moving the coupling selector to ground position will locate ground and display a reference dot at left edge of CRT.

Input R and C — 1 MΩ ±2% paralleled by approx 20 pF.

Max Input Voltage —

Dc coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.02 μs/div to 5.0 s/div (0.5 s/div in non-store mode) in a 1-2-5 sequence. X10 mag extends max sweep rate to 2 ns/div.

Time Base B — 0.02 μs/div to 5.0 s/div (50 ms/div in non-store mode) in a 1-2-5 sequence. X10 mag extends max sweep rate to 2 ns/div.

Variable Time Control — In storage modes has no effect. In non-store mode Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. LED warning light indicates uncalibrated setting.

Time Base Accuracy — full 10 cm
Storage Modes 0.1%.

Non-storage Mode

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes

Storage — A, B delayed

Non-Storage — A, A intensified, alternate, B delayed. B ends A for increased intensity in the delayed mode. Electronic switching between intensified and delayed sweep. A sweep and B sweep may be viewed simultaneously.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s.

Differential Time Measurement Accuracy—

Delay Time Setting	+15°C to +35°C
over one or more major dial divisions	±1%
less than one major dial division	±0.01 major dial divisions

Jitter — 1 part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

TRIGGERING A AND B

A Trigger Modes — Normal (sweep runs when triggered) automatic (sweep runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). LED lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. Non-store only.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B delayed sweep runs once, in each of these modes, following the A sweep delay time.

Storage Trigger Positions — Post-trigger point is at 1.25 div; Pre-trigger at 8.75 div.

Time Base A and B Trigger Sensitivity and Coupling —

Coupling	To 25 MHz	At 100 MHz
Internal	0.3 div deflection	1.5 div deflection
Dc		
External	50 mV	150 mV
External ÷10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac Lf Reject	Requirements increase below 50 kHz	
Ac Hf Reject	Requirements increase below 60 Hz and above 50 kHz	

STORAGE

Jitter — 0.5 ns or less at 100 MHz and 5 ns/div.

Digital Trigger Uncertainty — Correction circuit for the ±1/2 sample interval trigger uncertainty that is caused by asynchronous trigger/sample clock relationship.

A Trigger View — Electronically switched trigger view displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal which can be displayed simultaneously. The deflection factor is approx 100 mV/div (1 V/div with external ÷10).
Non-store mode only.

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

A Sources — Norm, Ch 1, Ch 2, line, external, and external ÷10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

Full-sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.
Non-store mode only.

DISPLAY

CRT — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 Phosphor standard; P11 optional. 18 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an offscreen signal. A pre-set intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz. Non-store mode only.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft. from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10-55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity as specified in MIL-T-28800B (par 3.9.2.2).

Shock — Operating and nonoperating: 30 g's 1/2 sine, 11 ms duration, 3 shocks per axis in each direction for a total of 18 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator		
Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — Ch 1 vertical signal is dc to at least 50 MHz (−3 dB), and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (approx 5 V).

Power Requirements — Quickchange line voltage selector provides four ranges to cover 90-132 V and 198-250 V. 48 to 440 Hz, 150 watts max at 115 V and 60 Hz.

Dimensions	in	cm
Height	6.2	15.7
Width (with handle)	12.9	32.8
Depth (with panel cover)	21.7	55.0
Depth (handle extended)	23.7	60.0
Weights (approx)	**lb**	**kg**
Net (without panel cover)	28.0	12.7
Net (with panel cover and accessories)	30.5	13.9
Shipping	42.2	19.1

INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03), blue accessory pouch (016-0594-00), clear pouch (016-0537-00), blue CRT light filter (337-1674-00), clear CRT light filter (337-1674-01), ground wire (134-0016-01), two 1 1/2 -amp fuses (159-0016-00), one 3/4-amp fuse (159-0042-00).

ORDERING INFORMATION

468 Oscilloscope $5,000

INSTRUMENT OPTIONS

International Power Cord and Plug Options

Option A1 Universal Euro 220 V/16 A . . . . . **No Charge**
Option A2 UK 240 V/13 A . . . . . **No Charge**
Option A3 Austrailian 240 V/10 A . . . . . **No Charge**
Option A4 North American 240 V/15 A . . . . . **No Charge**

Option 02 GPIB Output — Addressable talker; follows Tektronix codes and formats. . . . . **Add $750.00**

Option 04 Emc Modification . . . . . **Add $135.00**

Option 05 TV Sync Separator
(Provides triggering on TV field and line) . . . . . **Add $250.00**

Option 12 Signal Averaging, Average Mode — 2 to 256 sweeps can be averaged to improve signal to noise ratio. . . . . **Add $200.00**

Option 78 P11 Phosphor . . . . . **Add $35.00**

Modification kits, for field conversion of existing 468s to Option 02, are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for Information.

OPTIONAL ACCESSORIES

Optional Service ROM
This provides service and signature analysis routines for verification and troubleshooting the digital portion of the instrument. Recommended to be used with a TEKTRONIX 308 Data Analyzer. **067-0989-00**

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth*
P6063B 6 ft.	1X	1 MΩ 105 pF	6 MHz
	Switchable		
	10X	10 MΩ 14 pF	90 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ 2 pF	100 MHz
	100X Head	10 MΩ 2 pF	100 MHz
	Ac Head	10 MΩ 4 pF	100 MHz
Current Probe	**Calibration**	**Insertion Impedance**	
P6022 5 ft.	1 mA/mV	0.03 Ω at 1 MHz	85 MHz
	10 mA/mV (Selectable)	Increasing to 0.2 Ω at 120 MHz	

*Non-store modes — Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Folding Polarized Viewing Hood —
Order 016-0180-00 . . . . . **$27.00**

Collapsible Viewing Hood — Binocular
Order 016-0566-00 . . . . . **$15.00**

Protective Cover — Waterproof, blue vinyl
Order 016-0365-00 . . . . . **$21.00**

Mesh Filter — Improves contrast and emc filtering
Order 378-0726-01 . . . . . **$33.00**

SCOPE-MOBILE® CART — Occupies less than 18 in. aisle space, has storage area in base
Order 200C **$235.00**

1105 Battery Power Supply **$1,100.00**

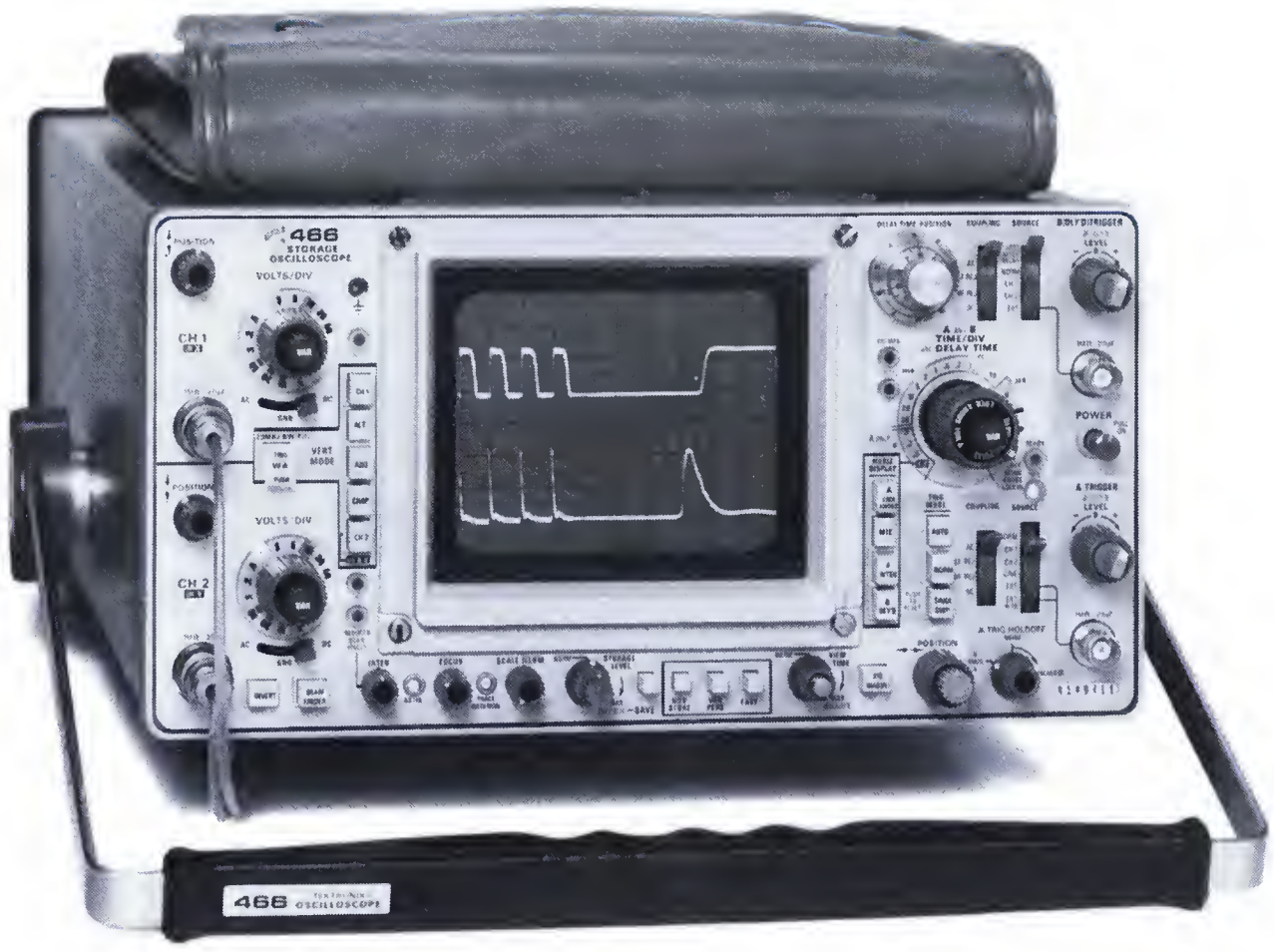
Rack Adapter 016-0675-00 . . . . . **$250.00**

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Compact Camera Includes 016-0301-00 mounting adapter/corrector lens.
Order C-30BP Option 01 . . . . . **$1,075.00**

For further information see Camera section.

100 MHz Dual Trace Storage Oscilloscopes



466/464

- 100 MHz at 5 mV/div
- 5 ns/div Sweep Rate with X10 Sweep Magnifier
- Variable Persistence and Fast Mesh Transfer Storage Modes
- 3000 div/μs Stored Writing Speed (466)
- Battery Operation (optional)
- Third Channel Trigger View now available on 466 and 464
- Weighs ≈26 lb

The 466 and 464 Portable Storage Oscilloscopes are both designed to display non-repetitive or slow moving signals. And with the exception of stored writing speed on the 466, both instruments offer similar performance.

Operating in a reduced scan mode, the stored writing speed of the 466 is 3000 div/μs (1350 cm/μs). The lower cost 464 doesn't offer a reduced scan mode and stores at 110 div/μs. Both instruments feature two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 cm CRT on both instruments comprises 0.90 cm/divisions. In the 466, reduced scan graticule is superimposed over the center of the main graticule, measuring 8 x 10 divisions with 0.45 cm/division. All graticules are etched onto the inner face of the CRT to eliminate parallax problems. A third channel trigger view option is now available for the 466 and 464. This option allows the simultaneous display of channels 1 and 2 with the external trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the 464 or 466 front panel when the probe attenuation factor is switched.

Light weight plus the ability to use optional, external dc power makes both the 466 and 464 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

CHARACTERISTICS

All characteristics apply to both the 466 and 464, except where indicated.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Rise Time — at all deflection factors from 50 Ω terminated source.

−15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, ≤3.5 ns	Dc to 85 MHz, ≤4.15 ns

*Measured at −3 dB down. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch. Lower −3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence); accurate ±3%. Uncalibrated, continuously variable between steps and to approx 12.5 V/div. In cascade mode sensitivity is approx 1 mV/div. Cascaded bandwith is at least 50 MHz when signal out is terminated in 50 Ω.

Display Modes — Ch 1, Ch 2 (normal or inverted), alternate, chopped (approx 250 kHz), added, X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 20 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by approx 20 pF.

Max Input Voltage —

Dc coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

Variable Time Control — Time Base A — Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy — full 10 div

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes — A, mixed sweep, A Intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep — Displays A sweep for period determined by DELAY-TIME POSITION control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to 10X delay time/div settings of 200/ns to 0.5 s (minimum delay time is 200 ns).

Differential Time Measurement Accuracy —

Delay Time Setting	+15°C to +35°C	−15°C to +55°C
over one or more major dial div	±1%	±2.5%
less than one major dial div	±0.01 major dial div	±0.025 major dial div

Jitter — 1 part or less in 50,000 (0.002%) of 10X the A sweep time/div setting.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

B Trigger Modes — B starts after delay time (starts automatically at the end of the delay time), B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling —

Coupling		To 25 MHz	At 100 MHz
Dc	Int	0.3 div deflection	1.5 div deflection
	Ext	50 mV	150 mV
	Ext ÷10	500 mV	1.5 V
Ac	Ac Lf Reject	Requirements increase below 60 Hz	
		Requirements increase below 50 kHz	
	Ac Hf Reject	Requirements increase below 30 Hz and above 50 kHz	

Jitter — 0.5 ns or less at 100 MHz and 5 ns/div (X10 mag).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

A Sources — Norm, Ch 1, Ch 2, line, external and external ÷10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

Third Channel Trigger View Specifications (Option 10)

Deflection Factor (Dc trigger coupling only)

EXT	100 mV/div ±5%
EXT ÷10	1 V/div ±5%

Delay difference (to Ch 1 or Ch 2) 3.5 ±1 ns

Trigger point is approximately center screen.

Risetime ≤5 ns.

Aberration <10% peak-to-peak.

X-Y OPERATION

Full Sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers In 3° or less from dc to 50 kHz.

DISPLAY

Crt — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div (reduced scan). 8.5 kV accelerating potential, normal-mode, 10 kV reduced scan. P31 Phosphor.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

STORED WRITING SPEEDS

	466	464	Storage* View Time
Full Scan (Center 6 x 8 div; 0.9 cm/div)			
FAST	150 div/μs	110 div/μs	>15s
VARIABLE PERSISTANCE	0.5 div/μs	0.5 div/μs	>15s
Reduced Scan (Center 8 x 10 div; 0.45 cm/div)			
FAST	3,000 div/μs	Reduced Scan not available on 464	>15s
VARIABLE PERSISTANCE	3 div/μs		>15s

*These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in SAVE Display Mode.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator —

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — Ch 1 vertical signal is dc to at least 50 MHz and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (approx 5 V).

Power Requirements — Quick-change line voltage selector provides six ranges: 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, 100 W max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

Dimensions	In	cm
Height (w/o pouch)	6.2	15.9
Width (with handle)	13.0	33.0
Depth (with panel cover)	21.7	55.0
Depth (handle extended)	23.5	59.7
Weights (approx)	**lb**	**kg**
Net (without panel cover or accessories)	26.0	11.8
Net (with panel cover and accessories)	29.8	13.5
Shipping	41.5	18.8

INCLUDED ACCESSORIES

Two P6062B Probes (010-6062-13), blue accessory pouch (016-0535-02), clear pouch (016-0537-00), CRT light filter (337-1674-01), two 1½-amp fuses (159-0016-00), one ¾-amp fuse (159-0042-00), adapter, ground wire (134-0016-01), viewing hood (016-0592-00).

ORDERING INFORMATION

466 Storage Oscilloscope **$6275**

466 DM 44 Storage Oscilloscope/ Multimeter DM 44 info on p. 155 ... **$6670**

464 Storage Oscilloscope **$5115**

464 DM 44 Storage Oscilloscope/ Multimeter DM 44 info on p. 155 ... **$5610**

INSTRUMENT OPTIONS

Option 01 delete DM 44 temperature probe (466 DM 44, 464 DM 44 only) ..... **Sub $85**

Option 04 Emc Modification ..... **Add $135**

Option 05 TV Sync Separator (Provides triggering on TV field) ..... **Add $250**

Option 07 Ext Dc Operation (Option 07 cannot be ordered with DM 44) .. **Add $210**

Option 10 Third Channel Trigger View ..... **Add $95 (Option 10 cannot be ordered with Option 05)**

Modification kits for field conversion of existing 466s and 464s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Field Engineer, Distributor, or Representative for information.

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 464/466
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz
	Switchable 10X	10 MΩ 14 pF	90 MHz
P6202 FET Probe	10X	10 MΩ 2 pF	100 MHz
2 Meter	100X Head	10 MΩ 2 pF	
	Ac Head	10 MΩ 4 pF	

Current Probe	Calibration	Insertion Impedance	Bandwidth with 464/466
P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz

*Bandwidths are measured at the upper −3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

OPTIONAL ACCESSORIES

1106 Battery Pack (used with Option 07) **$850**

1105 Battery Power Supply **$1100**

Mesh Filter — Improves display contrast In high ambient light. **Order 378-0726-01** **$33**

Protective Cover — Waterproof vinyl. For 464/466 **Order 016-0365-00** **$21**

Folding Viewing Hood — Order 016-0592-00 ..... **$12**

Folding Binocular Hood — Order 016-0566-00 .... **$15**

Polarized Collapsible Viewing Hood — Order 016-0180-00 ..... **$27**

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base. **Order 200 C** **$235**

Rack Adapter — Order 016-0676-00 ..... **$250** (Not for DM 44)

RECOMMENDED CAMERA

C-30BP Option 01 General Purpose Camera — Includes 016-0301-00 mounting adapter/corrector lens. **Order C-30BP Option 01** **$1075**

Camera Adapter — Mounts C-30B Series Camera to 464/466 Oscilloscopes. **Order 016-0301-01** **$95**

For further information see Camera section.

Tektronix offers maintenance training classes on instruments in the 400 Series and multi-media training packages on Digital Counter and Meter Concepts and Basic Oscilloscope Maintenance Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

10 MHz Dual Trace Storage Oscilloscope

314

10 MHz at 1 mV/div

100 ns/div Sweep Rate with X10 Sweep Magnifier

Stored Viewing Time to 4 Hours

Integrate Mode for Intensifying Fast Rise Time, Low Repetition Rate Signals

Operates from Ac Line, 12 V Dc, or 24 V Dc

Small Size, Weighs ≈ 10.5 lb

The 10.5 pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a 4 hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast rise time, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac, dc, or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

VERTICAL DEFLECTION

Bandwidth and Rise Time — Dc to at least 10 MHz. Rise time, 36 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Continuously variable between steps and to at least 25 V/div (uncalibrated).

Display Modes — Ch 1, Ch 2 (normal or inverted), chopped, alternate, added, and X-Y.

Input R and C — 1 MΩ paralleled by approx 47 pF.

Max Input Voltage — ac or dc coupled, 300 V (dc + peak ac).

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 5 s/div. X10 mag extends sweep rate to 100 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

Time Base Accuracy, center 8 div

Unmagnified	
1 μs/div to 0.2 s/div	±3%
0.5 s/div to 5 s/div	±4%
Magnified	
50 ms/div to 0.5 s/div	±5%
0.5 μs/div to 20 ms/div	±4%
0.1 μs/div and 0.2 μs/div	±5%

TRIGGER

Modes — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

Trigger Sources — Internal: Ch 1, Ch 2 or composite, external.

Trigger Sensitivity and Coupling

Coupling		To 1 MHz	At 10 MHz
Dc	Internal	0.3 div deflection	1 div deflection
	External	150 mV	500 mV
Ac	requirements increase below 30 Hz		
Ac Lf Reject	requirements increase below 50 kHz		

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both Ch 1 and Ch 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-axis Deflection Factors — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

Input Impedance — 1 MΩ ±2% paralleled by approx 62 pF.

DISPLAY

CRT — 8 x 10 div (0.6 cm/div) display. P44 Phosphor. 2 kV accelerating potential.

Graticule — Internal, non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

Z-axis input — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Max input voltage, 50 V (dc + peak ac).

STORAGE FEATURES

Display Modes — Direct view, bistable storage, and non-store modes. Enhance mode to increase stored writing rate in the single sweep mode. Auto erase mode to automatically erase stored display after each sweep. Viewing time before auto erase can be varied from 1 sec or less to at least 5 sec. Integrate mode increases stored brightness of very fast repetitive signals.

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

Erase Time — 300 ms.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: to 20,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 50,000 ft max.

Vibration — Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from −15°C to +55°C.

Power Sources — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 29 W at 115 V. External dc source, +11 V to +14 V or +22 V to +28 V with a max current drain of 1.6 A at +12 V or 0.8 A at +24 V.

Dimensions	in	cm
Height (w/o pouch)	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	13.6	34.7
Depth (handle extended)	17.6	44.8
Weights (approx)	**lb**	**kg**
Net (without accessories)	10.5	4.7
Shipping	17.0	7.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case and pouch (016-0612-00), external dc cable assembly (012-0406-00); strap (346-0131-00), two 1.6-A fuses (159-0098-00), two 0.8-A fuses (159-0132-00), two 0.15-A fuses (159-0130-00), three 0.16-A fuses (159-0131-00).

ORDERING INFORMATION

314 Storage Oscilloscope $3170

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

RECOMMENDED CAMERA

C-30BP General Purpose Camera $1050

Camera Adapter-Mounts C-30BP to 314. Order 016-0327-01 ..... $150

For further information see Camera section.

500 kHz Dual Trace Storage Oscilloscope

214

500 kHz, 1 mV/div to 50 V/div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈ 3.5 lb

The 214 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches). The 214 offers storage capabilities. This is useful for viewing non-repetitive or slow moving signals.

Built of impact-resistant plastic and fully self-contained, this miniature portable is ideal for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument — you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

VERTICAL DEFLECTION

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is less than 2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

Display Modes — Ch 1 only, Ch 2 only, or Ch 1 and Ch 2 chopped (approx chop rate — 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — Approx 1 MΩ paralleled by approx 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Max Input Voltage (1X probe only)

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz.
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac 5 MHz or less

HORIZONTAL DEFLECTION

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a max sweep speed of 1 μs/div.

External Horizontal Input — (Ch 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz less than 3°. Input characteristics same as Ch 1.

Max External Horizontal Input Voltage — 50 V (dc + peak ac), 100 V (p-p).

Input Impedance — R and C, 1 MΩ paralleled by approx 30 pF.

TRIGGER

Trigger Modes — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

Coupling		to 500 Hz
Dc	Internal (w/composite trigger source)	0.2 div
	Internal (w/ch 2 trigger source)	0.2 div
	External	1 V to 20 V p-p

Single Sweep — Sweep generator produces one sweep when trigger is received.

DISPLAY

CRT — Bistable storage, 6 x 10 div (0.52 cm/div) display P44 Phosphor.

Graticule — Internal, black line, non-illuminated.

STORAGE FEATURES

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

Stored Luminance — At least 8 fL.

Storage Viewing Time — Approx 1 hr.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only), −15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles. Held for three minutes at 55 Hz.

Humidity — 5 cycles (120 hours). ±95% relative humidity, referenced to MIL-E-16400F.

Shock — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide approx 5 hours operation (approx 3.5 hours in 214 stored mode) at max trace intensity for a charging and operating temperature between 20°C and 30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 min of operating time remaining in the batteries.

External Ac Source — 110 to 126 V, 58 to 62 Hz, 3 W. Can be operated at 104 to 110 V with resulting slow discharge of internal batteries.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms; or 1.4X line + peak ac) not to exceed 350 V.

Dimensions	In	cm
Height	3.0	7.6
Width	5.3	13.3
Depth	9.5	24.1
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.5	1.6
Shipping	7.0	3.2

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), two 4-A fuses (159-0121-00), identification tags (000-7983-00), identification tag (334-2614-00), carrying strap (346-0104-00).

ORDERING INFORMATION

214 Dual-Trace Storage Oscilloscope, including batteries $1925

POWER OPTIONS

Option 01 for 220-250 V, (48 to 52 Hz) Includes batteries ..... No Charge

Option 02 for 90 to 110 V, includes batteries ..... No Charge

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, approx 20 pF) and higher max input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adapter (206-0203-00).
Order 010-0378-01 ..... $45

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $16

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $8

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... $9.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $7

10 MHz Dual Trace Storage Oscilloscope

T912

10 MHz at 2 mV/div

250 cm/ms Stored Writing Speed

50 ns/div Sweep Rate (with X10 Sweep Magnifier)

8 x 10 cm Bistable Storage CRT

Weighs ≈17.5 lb

Differential Input Option

The T912 Storage Oscilloscope is well-suited for a wide range of applications in education and industry. As a training aid in basic electricity and electronics courses, the storage feature is highly useful in creating visual representations of electrical signals. In physics and engineering courses, storage permits the user to capture and display single-shot events like the pressure curve generated in the chamber of an engine or the stress-strain characteristics of a material undergoing destructive testing.

The T912 has similar industrial applications, where it can also be used to compare input vs feedback signals in servo-mechanisms, for shock and vibration analysis, and countless other transducer-aided measurements.

Besides bistable storage, the T912 offers other features seldom found in economy-model oscilloscopes. These include a delay line, which allows you to view the leading edge of fast-rising signals; a 12-step calibrated vertical attenuator; constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimeter; 19 calibrated sweep rates ranging from 0.5 s to 500 ns/cm; 3% amplitude and timing accuracy; and minimal corner shift over a broad vertical dynamic range.

The T912 may be ordered with a differential input option. In DIFF mode, the T912 displays the difference between Channel 1 and Channel 2 signals. The Channel 2 signal is automatically inverted: the algebraic sum of the Channel 1 signal and the inverted Channel 2 signal is then displayed on the CRT.

VERTICAL SYSTEM

Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Dual Trace — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings ≥ 1 ms/div, alternate for settings ≤ 500 μs/div. Trigger is derived from Ch 1 signal only.

Deflection Factor

Range — 2 mV/div in 12 steps in a 1-2-5 sequence.

Accuracy —	
+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 10 MHz (measured at −3 dB).

Rise Time — 35 ns or less.

Chopped Mode Repetition Rate — ≃ 250 kHz.

Input Resistance — ≃ 1 MΩ.

Input Capacitance — ≈ 30 pF.

Max Input Voltage —

Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.5 μs/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 50 ns/div.

Accuracy —

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Single Sweep — Displays one sweep only. Sweep cannot be triggered again until reset.

Slope + Out − in — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≃ 1 MΩ.

Input Capacitance — ≃ 30 pF.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≈100 mV/div (X10 mag), ≈1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Phase Difference Between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT STORAGE DISPLAY

Writing Rate — At least 25 cm/ms.

Enhanced Writing Rate — At least 250 cm/ms.

Display Area — 8 x 10 cm, internal graticule.

Storage Phosphor — P1.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≈2.76 kV.

POWER SOURCE (AC)

Line Voltage Ranges — HI-LO range accessible externally; 110-120 V, 220-240 V line selector visible but not accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 65, amps (max) 0.6, at 120 V, 60 Hz.

PROBE ADJUST

Output Voltage — ≈0.5 V.

Repetition Rate — ≈1 kHz.

Z-AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Usable Frequency Range — Dc to 5 MHz.

Input Impedance — ≈10 kΩ.

ENVIRONMENTAL CAPABILITIES

Temperature

Nonoperating — −55°C to +75°C.

Operating — 0°C to +45°C.

Altitude

Nonoperating — To 15,200 meters; 50,000 feet.

Operating — To 4,500 meters; 15,000 feet max. Operating temperature decreased 1°C/304.8 meters (1,000 feet) above 1524 meters (5,000 feet).

PHYSICAL CHARACTERISTICS

Dimensions	**in**	**cm**
Height	10.0	25.4
Width	7.09	18.0
Depth	18.7	47.5
Weight (approx)	**lb**	**kg**
Net (with panel cover)	18.0	8.2
Net (w/o panel cover)	17.5	7.9

INCLUDED ACCESSORIES

Probes — 2 each. P6006 general purpose 10X voltage probes. Provides full bandwidth capabilities for the T912.

ORDERING INFORMATION

T912 — Dc to 10 MHz, Dual-Trace, Single Time Base Storage Oscilloscope (includes two 10X probes) $1800

Option 01, Differential Input . . . . . Add $80

15 MHz Oscilloscopes

T921 15 MHz Single-Trace Oscilloscope

T922 15 MHz Dual-Trace Oscilloscope

- Dc to 15 MHz at 2 mV/div
- 20 ns/cm Sweep Rate with X10 Sweep Magnifier
- Bright (12 kV) Display
- Easy to Use
- Regulated Power Supplies
- Differential Input Option (T922 only)
- Weighs ≈15 lb

The T921 (single-trace) and T922 (dual-trace) Oscilloscopes provide the basic functions of a general-purpose oscilloscope at the lowest price consistent with quality construction and reliable performance. Small and easy to operate, they are an excellent choice for the student's workbench in basic electricity, electronics, and physics classes. The same characteristics suit them well for production line applications wherever electronic components, circuits, or equipment must be tested or calibrated. In the manufacturing and servicing of consumer electronics the T921 and T922 are a cost-effective answer to most test and measurement requirements. As a signal processing, measurement and display device for dynamic transducer measurements, both oscilloscopes offer superior performance at a relatively low cost.

Although lightweight (15 lb) and small (7 x 10 x 19 inches), the T921 and T922 provide an especially bright, high resolution, 8 x 10 cm CRT display. Even in high ambient light conditions, low-rep-rate signals are easily viewed. Their features shorten familiarization time and help make day-to-day measurements easier and more accurate. Functionally related controls are color coded for easy identification and grouped together for convenience. Chopped or alternate sweep modes are selected automatically to yield the best display for the selected sweep rate. An option for differential input may be ordered with the T922. In DIFF mode, the T922 displays the difference between Channel 1 and Channel 2 signals. The Channel 2 signal is automatically inverted; the algebraic sum of the Channel 1 signal and the inverted Channel 2 signal is then displayed on the CRT.

Measurement accuracy of the T921 and T922 is superior to most similarly priced oscilloscopes. A twelve-step attenuator provides calibrated deflection factors ranging from 2 mV/cm to 10 V/cm. Both models offer ±3% vertical amplitude and sweep timing accuracy, with minimal corner shift over a broad vertical dynamic range.

VERTICAL SYSTEM

Mode Selections

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal (T922 only).

Dual Trace (T922 only) — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings ≥1 ms/div, alternate for settings ≤500 μs/div. Trigger is derived from Ch 1 signal only.

Differential Input (T922 Option 01) — Adds Ch 1 and Ch 2 and automatically inverts Ch 2 for a differential display.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —	
+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 15 MHz (measured at −3 dB).

Rise Time — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — ≈250 kHz.

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Max Input Voltage — Dc Coupled—400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac Coupled—400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 20 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

TV — Provides triggering on TV field when SEC/DIV switch is set at 0.1 ms or slower. Triggers on TV line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Triggering Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz.

TV — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≈100 mV/div (X10 mag), ≈1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Phase Difference between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≈12 kV.

Z-axis Input — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 5 MHz. Input impedance ≈10 kΩ.

PROBE ADJUST

Output Voltage — ≈0.5 V.

Repetition Rate — ≈1 kHz.

POWER SOURCE (AC)

Line Voltage Ranges — HI-LO range accessible externally; 110-120 V, 220-240 V line selector visible but not accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

Canadian Standards Association certified.

ENVIRONMENTAL CAPABILITIES

Temperature

Nonoperating — −55°C to +75°C.

Operating — −0°C to +45°C.

Altitude

Nonoperating — To 15,200 meters; 50,000 feet.

Operating — To 4,500 meters; 15,000 feet max. Operating temperature decreased 1°C/304.8 meters (1,000 feet) above 1524 meters (5,000 feet).

PHYSICAL CHARACTERISTICS

Dimensions	in	cm
Height	10.0	25.4
Width	7.09	18.0
Depth	18.7	47.5

Weight (approx)	lb	kg
Net (with panel cover)	15.5	7.0
Net (w/o panel cover)	15.0	6.8

INCLUDED ACCESSORIES

Probe — P6006 general-purpose 10X voltage probe for each channel. Provides full bandwidth capabilities for either the T921 or the T922.

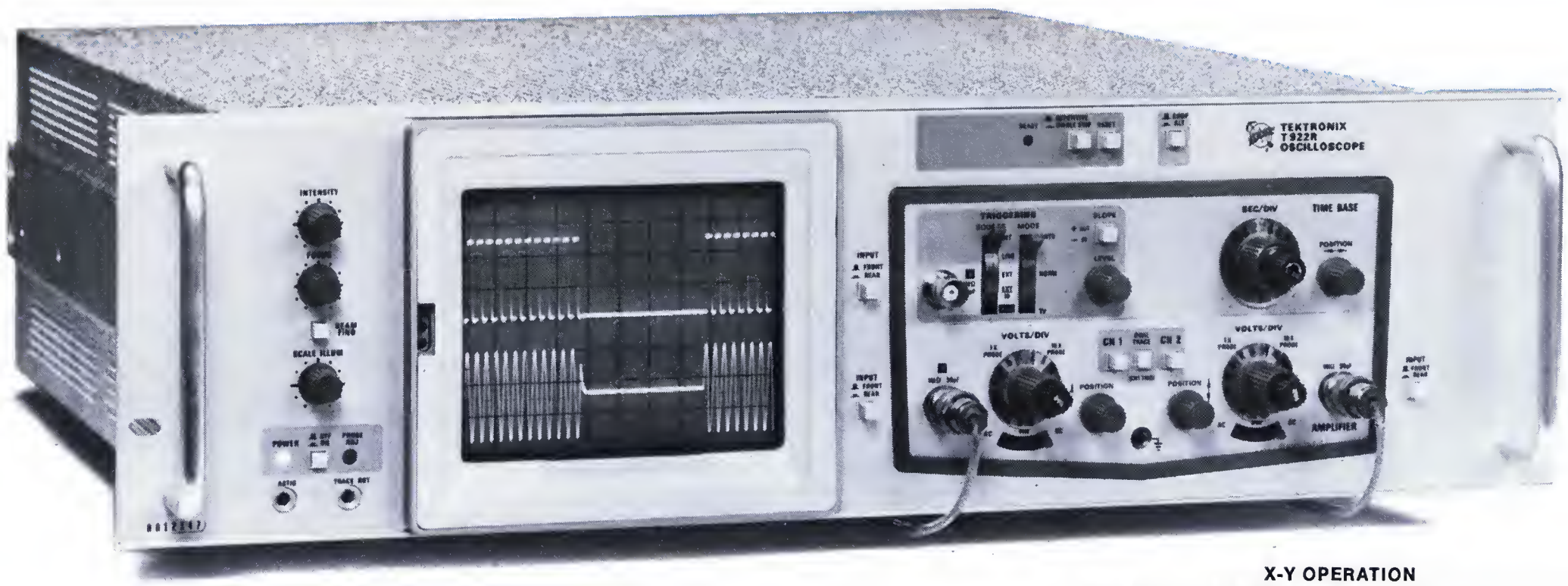
ORDERING INFORMATION

T921 — Dc to 15 MHz, Single-Trace, Mono Time Base Oscilloscope (includes one 10X probe) $930

T922 — Dc to 15 MHz, Dual-Trace, Mono Time Base Oscilloscope (includes two 10X probes) $1090

Option 01, Differential Input for T922 ..... Add $80

15 MHz Dual Trace Rackmount Oscilloscope



T922R

Dc to 15 MHz at 2 mV/div

Switchable Front and Rear Signal Inputs

Only 13.3 x 48.2 x 43.2 cm, 9.1 kg (5.25 x 19 x 17 in, 20 lb)

Single Sweep Operation

Bright (12 kV) Display

The T922R Oscilloscope is our rackmountable version of the popular T922. In addition to standard features like its 15 MHz bandwidth at 2 mV/div vertical sensitivity and its 20 ns/div maximum sweep rate with the X10 magnification control, we've added switchable front and rear signal inputs, selectable chop and alternate sweeps, graticule illumination and rear panel outputs (gate out, sweep out and vertical signal out). The T922R fits any standard 19 inch (48 cm) rack and weighs only 20 pounds (9.1 kg). Option 01 adds the differential capability.

Many companies are using the T922R for their production testing applications—often as an inexpensive replacement for aging instruments which require frequent repair and calibration.

T922R SPECIFICATIONS

Seven recessed rear panel BNC connectors provide: Ch 1, Ch 2 vertical signal input, External trigger input, Z-axis input, Sweep Output, Gate Output, Vertical Output.

VERTICAL SYSTEM

Mode Selections

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Dual Trace — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is manually selectable.

Deflection Factor

Range — 2 mV/div to 10V/div in 12 steps in a 1-2-5 sequence.

Accuracy —

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 15 MHz (measured at −3 dB).

Rise Time — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — ≃ 250 kHz.

Input Resistance — ≃1 MΩ.

Input Capacitance — 30 pF.

Maximum Input Voltage — Dc coupled, 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac coupled, 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 20 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +40°C	Within 4%	Within 6%

Z-AXIS INPUT

Sensitivity — 5 V signal causes noticeable intensity modulation. Polarity of the voltage causing a decrease in intensity is internally selectable.

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

TV — Provides triggering on TV field when SEC/DIV switch is set at 0.1 ms or slower. Trigger on TV line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out — In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Triggering Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz.

TV — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Maximum Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≃ 1 MΩ.

Input Capacitance — 30 pF.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≃ 100 mV/div (X10 mag) ≃ 1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≃ 1 MΩ.

Input Capacitance — 30 pF.

Phase Difference Between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, illuminated internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≃12 kV.

PROBE ADJUST

Output Voltage — ≃ 0.5 V.

Repetition Rate — ≃ 1 kHz.

OUTPUTS

Sweep/Gate Out — Output Voltage is ≃ 5 V positive going into 1MΩ, ≃ 50 mV into 50 Ω load.

Vertical Output — a composite of Ch 1 and Ch 2 with ≃ 0.5 V output per displayed division into a 1 MΩ load. ≃ 50 mV with 50 Ω load. Bandwidth is at least 1 MHz.

POWER SOURCE (AC)

Line Voltage Ranges — 100-120 V, 220-240 V line voltage and HI/LO range are accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 50, amps (max) 0.35, at 120 V, 60 Hz.

Canadian Standards Association certified.

PHYSICAL CHARACTERISTICS

Dimensions	In	cm
Height	5.25	13.3
Width	17.0	43.2
Depth	19.0	48.2
Weight	**lb**	**kg**
Net	20.0	9.1

For environmental performance, see T922 information, page 173.

CAMERAS

T922R interfaces to all Tektronix Cameras.

ACCESSORIES

None included as standard equipment.

ORDERING INFORMATION

T922R — Dc to 15 MHz, Dual-Trace, Mono Time Base $1555

Option 01, Differential Input ..... Add $80

OPTIONAL ACCESSORIES

Rackmount Hardware Kit
Order 016-0375-00 ..... $60

35 MHz Dual Trace Oscilloscopes

T932A 35 MHz Dual-Trace Oscilloscope

T935A 35 MHz Dual-Trace Oscilloscope with Delayed Sweep

T932A / T935A

- 35 MHz at 2 mV/div
- 10 ns/div Sweep Rate (with X10 Sweep Magnifier)
- Differential Display
- Full Sensitivity X-Y Capability
- Ac and Dc Trigger Coupling
- Composite, Ch 1 or Ch 2 Triggering
- Selectable Chop/Alternate
- Trigger Holdoff
- Weighs ≈15 lb

Meet the two newest members of our T900 Oscilloscope Family — the T932A and the T935A. With these models we've added differential and full sensitivity X-Y capabilities, dc trigger coupling, a composite trigger and selectable chop/alternate display modes to the Tektronix line of low-cost portable oscilloscopes.

The T932A and T935A 35 MHz Dual-Trace Oscilloscopes are designed for cost-sensitive applications that require greater measurement capability than the T921/T922 Oscilloscopes offer. Typical applications include design, production-line testing, and servicing of digital equipment such as computer peripherals, point-of-purchase data processors, numerical machine controls and consumer electronics.

Other T932A and T935A features seldom found in moderately-priced oscilloscopes include delayed sweep (the T935A) and trigger holdoff capabilites. Displayed signals that do not reveal sufficient detail on the time base A sweep may be selectively expanded using the delayed sweep feature and displayed on the B sweep. The trigger hold-off function permits adjustment of the sweep repetition frequency without changing sweep time per centimeter. Both features are valuable measurement aids, especially in digital design and service applications.

When making measurements which require delayed sweep, the T935A is the logical choice. Except for this feature, it is identical to the T932A.

VERTICAL SYSTEM

Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Chop — Displays Ch 1 and Ch 2 signals simultaneously (chop rate 250 kHz), triggers on Ch 1 or Ch 2 signal.

Alt — Displays Ch 1 and Ch 2 signals alternately, triggers on Ch 1 or Ch 2 signal.

Diff — Displays difference between Ch 1 and Ch 2 signal; Ch 2 automatically inverted.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —	
+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 35 MHz (measured at −3 dB).

Rise Time — 10 ns or less.

Chopped Mode Repetition Rate — ≈ 250 kHz.

Input Resistance — ≈ 1 MΩ.

Input Capacitance — ≈ 30 pF.

Max Input Voltage — Dc coupled, 250 V (dc + peak ac) at 1 kHz or less. Ac coupled, 250 V (dc + peak ac) at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range

A Sweep — 0.5 s/div to 0.1 μs/div in 21 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

B Sweep — (T935A only) 50 ms to 0.1 μs/div in 16 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

Delay Time Position Range — (T935A only) 0.5 to 10 div (uncalibrated).

Delay Time Jitter — (T935A only) One part or less in 10,000 (0.01%) of ten times the SEC/DIV switch setting.

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

TV — Provides triggering on TV field when SEC/DIV switch is set at 0.1 ms/div or slower. Triggers on TV line when SEC/DIV switch is set at 50 μs/div or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Holdoff — Permits adjustment of time interval between end of sweep and next acceptable trigger to achieve stable displays of complex words.

35 MHz Dual Trace Oscilloscopes

Coupling

Ac (switch out) — Blocks dc (<60 Hz) component of triggering signal and allows triggering on ac portion of signal.

Dc (switch in) — Passes all components of triggering signal from dc to at least 35 MHz.

Trigger Source

Comp (composite) — Trigger signal is derived from the displayed vertical signal.

Ch 1/Ch 2 (Internal) — Trigger signal is derived from either the Ch 1 or Ch 2 signal as described in the vertical mode section.

Line — Trigger signal is derived from the line voltage frequency.

Ext (external) — Trigger signal is derived from the signal applied to the external trigger input.

EXT/10 (external ÷10) — External signal is attenuated by a factor of 10.

X-Y — Permits X-Y displays when Ch 2 vertical button is depressed.

Trigger Sensitivity

Auto and Norm —

Ac — 0.5 div internal or 100 mV external from 60 Hz to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

Dc — 0.5 div internal or 100 mV external from dc to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

TV — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Max Input — 250 V (dc + peak ac) 500 V p-p ac at 1 kHz or less.

Input Resistance — ≈ 1 MΩ.

Input Capacitance — ≈ 30 pF.

X-Y OPERATION

(Ch 1-X, Ch 2-Y)

Sensitivity — Same as Ch 1 and Ch 2.

Accuracy — 20 to 30°—±5%.
0 to 45°C—±6%.

X-Axis Bandwidth — Dc to at least 2 MHz (measured at —3 dB).

Input Resistance — ≈ 1 MΩ.

Input Capacitance — ≈ 30 pF.

Phase Difference between X and Y Axis Amplifiers — Within 3° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off-screen displays.

Nominal Accelerating Potential — ≈ 12 kV.

PROBE ADJUST

Output Voltage — ≈ 0.5 V.

Repetition Rate — ≈1 kHz.

Z-AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Usable Frequency Range — Dc to 5 MHz.

Input Impedance — ≈ 10 kΩ.

POWER SOURCE (AC)

Line Voltage Ranges — HI/LO range accessible externally; 110-120 V, 220-240 V line selector visible but not accessible externally.

100-120 V Range — HI: 110 to 132 V rms. LO: 92 to 110 V rms.

220-240 V Range — HI: 220 to 250 V rms. LO: 202 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max), 50 amps (max) 0.35, at 120 V, 60 Hz.

UL Listed. Canadian Standards Association certified.

For environmental performance, weights and dimensions, see T922 information on page 173.

INCLUDED ACCESSORIES

Probes — 2 each. P6108 general purpose 10X voltage probe provides full bandwidth capability for either the T932A or T935A.

ORDERING INFORMATION

T932A — Dc to 35 MHz, Dual-Trace, Mono Time Base Oscilloscope (includes two 10X probes) $1390

T935A — Dc to 35 MHz, Dual-Trace, Mono Time Base (with Delayed Sweep) Oscilloscope (includes two 10X probes) $1720

T900 Accessories

C-5C CAMERA

Recommended for all T900 Series Oscilloscopes, the C-5C attaches directly to the front panel without adapters and uses Polaroid pack film. A fixed f/16 lens aperture, an electric shutter with timed speeds from 0.1 to 5 seconds, plus open shutter mode, and bulb, combine to make the C-5C a rugged, low-cost scope camera. Bench model T900 Oscilloscopes use the C-5C Option 03 which includes a built-in Xenon flash unit that flashes to illuminate the graticule when the shutter opens. The T922R uses the C-5C Option 01, without the Xenon flash. Batteries are not included for either version.

Order C-5C, Option 03 . . . . . $425
C-5C, Option 01 . . . . . $385

An NTSC IRE TV graticule is available. Ask your local Tek Sales Engineer or Representative.

VIEWING HOOD

Provides for convenient viewing in high ambient light conditions.

Order Viewing Hood (016-0377-00) $8

PROTECTIVE COVERS

Front Panel Cover

Snaps over the oscilloscope front panel to protect controls during transport or storage. Molded from high-impact-resistant plastic. Storage compartment for two probes and cables is built into inner side.

Order Protective front cover (016-0340-00) $20

Dust Cover/Rain Jacket (not shown)

Provides protection against dust accumulation when not in use, and against rain and snow during transportation. Constructed of 15 mil tough durable vinyl. An opening at the top allows access to the oscilloscope handle.

Order Protective cover (016-0361-00) $20

209 SCOPE STAND

Supports any benchtop T900 Oscilloscope at convenient angle for viewing and easy access to controls. Quickly disassembled, it forms a lightweight (3 lb) package that can be neatly attached to the bottom of the oscilloscope for easy carrying. Consists of a molded plastic base, support bracket, and a 15 in (38 cm) aluminum support column.

Order: 209 Scope Stand $85

Data Communication Analyzers

Communications System Monitoring

Bisynchronous System Exercising

Data Link Testing

Communications Equipment Check-out

New Concepts in Digital Service

834 Programmable Data Communication Tester	178-180
833 Data Communication Tester	181-182
832 Data Communication Tester	181-182
851 Digital Tester	184

Programmable Data Communication Tester

NEW **834**

Programmable

Easy to Operate

19.2 K Baud Data Transfer

2699 Character Storage Buffer

16 Character Display

BERT/BLERT

Portable and Lightweight

The Tektronix 834 Programmable Data Communications Tester is a powerful network troubleshooter designed to meet the demand for cost and time-effective first-line field service. The 834's portability (5.5 kg, 12 lb), ruggedness, and ease of use gives you a welcome independence from bulky, expensive equipment.

The 834, like our 833, monitors and is compatible with EIA RS-232 and CCITT V.24 interfaces; provides DTE and DCE simulation to evaluate the entire network; BERT/BLERT analysis for testing phone lines and modems; the ability to calculate and confirm block check characters; and internal self-diagnostics.

The fast 19.2 kilobaud rate lets you test the most modern networks. The bright 16 character front panel display is fully decoded in ASCII, EBCDIC, HEX, or your own character set.

We've programmed common test messages and setups into a series of optional User ROM Packs that field personnel easily slip into the 834 to quickly isolate faults. The Packs can set up the front panel controls automatically, or allow the user to execute specific test programs for special on-site applications.

MODES OF OPERATION

Monitor

The 834 monitors and records activity occurring on the RS-232 interface without interfering with data transmission. Trigger capability allows selective capture of data (refer to Triggering).

Modem (DCE) Simulation

In this mode, the 834 functions as Data Communications Equipment (DCE) or modem simulator for testing the Data Terminal Equipment (DTE). Messages can be sent to the unit under test (UUT), and messages received from the UUT can be examined for trigger events which can cause further action by the 834. The sequence of events is controlled by a stored program (in the 834) which can be manually entered or stored in a user defined ROM (refer to Programmability).

Terminal (DTE) Simulation

In this mode, the 834 performs as Data Terminal Equipment (DTE) or terminal simulator for testing the Data Communications Equipment (DCE) side of the interface. Otherwise, operation is similar to the modem (DCE) simulator mode described above (refer to Programmability).

Self Test Mode

In this mode, internal diagnostics and exercising routines can be called up by the operator to verify the instrument is functioning properly.

INTERFACE COMPATIBILITY

The 834 is compatible with EIA RS-232 and CCITT V.24 interfaces.

ELECTRICAL

Data Transmission Timing

Synchronous and Asynchronous.

Communications Mode

Half or full-duplex.

Bits Per Character — 5, 6, 7, 8, 9. 5 bit/character cannot be selected with parity; 9 bit/character cannot be selected without parity and in the asynchronous mod only.

Codes

ASCII, EBCDIC, HEX standard. Space available for user defined codes in an optional USER ROM.

Data Transfer Rates

Internal (crystal controlled) — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, and 19,200 bits per second. (Synchronous full-duplex restricted to ≤9600 bits per second.)

External — Limited to maximum of 19,200 bits per second. Synchronous full-duplex restricted to ≤9600 bits per second.

Parity

None, Odd, Even, all Mark, all Space.

RTS/CTS Delay (Half-Duplex Mode Only)

Programmable from 0 to 9999 ms. If not programmed, defaults to 200 ms.

Accuracy — +5, −15 ms.

Block Check Characters

CRC-16, CRC-CCITT, LRC.

Bit Error Rate/Block Error Rate Tests

Utilizes the 511-bit CCITT standard pseudo-random pattern sent in blocks of 1000 bits; errors are counted continuously or over a total test length of 10^5 or 10^6 bits; stores bits in error, blocks sent, blocks in error and sync faults.

SET-UPS

Asynchronous Operation

Stop Bits — Transmits 1, 1.5 or 2. Responds to 1.

End of Frame — One programmable character (any bit combination). Defaults to 0A. (ASCII New line).

Timing — Normal or Isochronous.

Synchronous Operation

Synchronizing Character — Programmable to require any 1 or 2 characters (if 2, they may be different). Defaults to 32 32.

End of Frame — Programmable to recognize any of a number of idle conditions (Mark, Space, Syn) and/or a single character (defaults to 37, EBCDIC EOT).

Clock — Normal, Derived, DTE.

HDLC Operation

NRZI — On or Off.

Clock — Normal, Derived, DTE.

TRIGGERING

Trigger Location in Buffer —Start, Center, End.

Match — Source of data being searched for trigger events: (NONE, DTE, DCE).

Trigger Sequence — Programmable to require a sequence of 0-25 characters (0-5 if no mask programmed).

Mask Sequence — Programmable to mask a 0-25 character trigger sequence.

Error Conditions — In Async: A parity or frame error. In Sync: A parity error. In HDLC: A CRC error, an abort sequence, or a short frame (<32 bits).

Marker — Low-to-high or high-to-low transition of marker input can be selected.

Buffer Capacity — 2699 characters.

PROGRAMMABILITY

Program Steps — 99 steps available.

Message Lengths — 50 messages totaling 3000 bytes.

Data Captured — Always the last 2699 characters received before the program stops or before STOP is pressed.

Instruction Set —

HALT: mm
Stop and display message MM.

SEND: mm
Send contents of message buffer MM as a frame.

RECEIVE
Obtain next complete data frame for processing.

COMPARE: mm
Search frame for a match with message buffer MM.

JUMP EQ: ss
Jump to step SS if a match is found.

JUMP NE: ss
Jump to step SS if a match is not found.

JUMP: ss
Jump to step SS.

IF TIME: ss
Jump to step SS if the timer expires.

TIME OUT # pp
Start timer with value parameter PP.

MASK: mm
Use message MM for mask during COMPARE operation.

WAIT # pp
Start time with value in parameter PP and do not proceed to following step until timer expires (10 to 9999 ms).

BREAKOUT PANEL

Probe

Space: $+3V \leq V_{in} \leq +25$ V

Mark: -25 V $\leq V_{in} \leq -3$ V

Input Impedance: ≥50 KΩ

Marker

Mark or Off: -25 V $\leq_{in} \leq +0.8$ V

Space or On: $+2$ V $\leq_{in} \leq +25$ V
(Schmitt Input)

+12 Volt Source

+12 V ±1 V (no load). Output impedance approx. 3K Ω (each pin).

−12 Volt Source

−12 V ±1 V (no load). Output impedance approx. 3K Ω (each pin).

DISPLAY

Alphanumeric Display

16-digit fluorescent display. Each digit is a 5 x 7 dot matrix 0.35 in (9 mm) high. LED status indicators for control lines.

PHYSICAL CHARACTERISTICS

Dimensions and weights (approx.)

	in	mm
Height	4.0	102
Width	12.1	305
Length	12.4	306
	lbs	**kg**
Net Weight	12	5.5

POWER REQUIREMENTS

Line Voltage Ranges

115 V — 90 to 132 V

230 V — 180 to 250 V

Line Frequency Range

48 to 440 Hz.

ENVIRONMENTAL

Temperature

Operating: 0° to +50°C (+32° to +122°F)
Non-Operating: −40° to +75°C (−40° to +167°F).

Humidity

30° to 60°C, 95% relative humidity.

Altitude

Operating: To 15,000 feet (4500 m).
Non-operating: To 50,000 feet (15,000 m).

Shock

50 g's, ½ sine. 11 ms duration, in each major axis.

INCLUDED ACCESSORIES

RS-232 cable assembly, jumper set (198-4006-00), power cord — US. 115 V (other optional) (161-0066-00) Operators Manual, Users Guide.

ORDERING INFORMATION

834 Programmable Data Communications Tester $3,700

Option 02 Current Loop Interface ..... Add $300

Option 04 MIL. STD. 188C $350

834R01 General Purpose User ROM Pack $240

834R02 Bisynchronous User ROM Pack $320

834R03 Link Test ROM Pack $340

International Power Cord and Plug Options

Option A1 Universal Euro 220 V/16 A ..... **No Charge**
Option A2 UK 240 V/13 A ..... **No Charge**
Option A3 Austrailian 240 V/10 A ..... **No Charge**
Option A4 North American 240 V/15 A ..... **No Charge**

OPTIONAL ACCESSORIES

Current Loop Pod Accessory 015-0361-00 ..... $325

User ROM Pack (empty) 020-0607-00 ..... $80

Diagnostic ROM Pack 067-0986-00 ..... $480

Carrying Case 016-0672-00 ..... $70

Programmable Data Communication Tester

These products are firmware extensions of the 834 Programmable Data Communications Tester, an instrument designed for trouble-shooting digital data-communications networks.

The ROM Pack contains 3 basic types of information: (1) Standardized routines for common or specific applications. (These routines are preprogrammed versions of capabilities which are available from the front panel of the 834); (2) Extended capabilities (these are features not available in the 834 but are available with use of the ROM Pack); (3) Custom ROM Pack capability (this feature enables the user to program custom applications into this ROM Pack). The 834 ROM Packs contain three 2K Byte ROMS. There is room for 1 additional ROM reserved for customer use. This ROM represents 4K Bytes of address space and can accommodate a 2K or 4K ROM or EPROM. The custom ROM area of the ROM Pack can be programmed using 2716, 2732, 2516, or 2532 single power supply EPROMS.

834R03

834R03 Link Test ROM Pack affords an extended set of transfer functions especially designed for testing Data Communication Links, an extended set of programming instructions, and an extended variety of test patterns and lengths for BERT testing.

834R03 additions to basic 834:

- Extra patterns 63, 2047, 1:1, 1:0, 0:1, 3:1, 1:3, 7:1, 1:7.
- Extra test lengths 10^4, 10^7.
- Alternate block size—511 bits (V.52).
- Alternate test-bias distortion.
- Alternate termination—minutes.
- Split baud rates.
- Simulation tests
  - —Handshake test.
  - —Ping-pong test (half and full duplex).
  - —Half duplex BERT (V.52 compatible).
- Over and Under baud rate test ±1, 2.5%.
- Block compare simulation instruction.

834R01

The 834R01 general purpose ROM Pack simplifies and expands operation of the 834 Data Communications Tester for use with asynchronous systems.

The capabilities programed into the 834R01 are as follows:

- Sets up conditions for asynchronous operation upon instrument power up.
- The addition of correspondence and baudot character decode tables.
- Additional idle menu selection.
- An expanded programming set, providing 16 additional program instructions.
- Split baud rate capability allowing the change of either the transmit or receive baud rate.
- Basic printer tasks:

  Tester sends a message in lines of increasing length to a DTE to verify that characters are positioned and printed properly. Test also evaluates DTR response and X-on, X-off feature.
- Repeat mode (with and without trigger).
- Correspondence code set-up. (This sets the 834 to the most common asynchronous setups available).
- Baudot code set-up. (This sets up the 834 for the most common Baudot code set-up.)
- Block asynchronous setup. (This sets up the 834 to operate in the block-asynchronous mode.)
- Graphic test patterns. This program is useful for calibrating screen attributes in Tektronix 4010 Series Terminals.

834R02

The 834R02 Bisynchronous ROM Pack extends and simplifies use of the 834 in exercising components of the IBM 3270 Information Display System family and compatible terminals manufactured by other companies.

The capabilities programmed into the 834-R02 are as follows:

Monitor Routines:

- Trigger on NAK.
- Trigger on RVI.

Simulation Routines:

- Attribute Exercise Pattern.
- "E" Alignment Patterns.
- New Line/End-of-Message Pattern.
- 81 Character Stairstep Pattern.
- Control Key Response Test.

Utility Routines:

- Calculate BCC (STX to ETX & SOH to ETX).
- Terminal Startup.
- Read and Display Terminal Status.

Set-up Changes:

- Setup for ASCII Bisync.
- Setup for EBCDIC Bisync.
- Load Common Protocol Messages and Parameters.

An expanded programming set, providing 16 additional program instructions.

CUSTOM ROM PACKS

The ROM Pack can be customized by inserting a properly coded EPROM into the ROM Pack. To simplify this process, Tektronix offers a translation service to encode custom programs into EPROMS. The customer provides Tektronix with completed copies of coding sheets (provided with operator's manual) for an application. For a fee Tektronix will return to the customer a listing of the translation and two master EPROM's containing the translated code.

ORDERING INFORMATION

834R01 General Purpose User ROM Pack **$240**

834R02 Bisynchronous User ROM Pack **$320**

834R03 Link Test ROM Pack **$340**

Additional ROM Packs will become available through the year to handle a wide variety of applications.

833

- Microprocessor controlled
- 256 character stoarge buffer
- BERT/BLERT capabilities
- CRC character calculation
- String search
- Easy to operate
- Portable and lightweight

The TEKTRONIX 833 Data Communications Tester is a high-performance, first-line service tool that provides the service technician with the means to locate problems in a data communications network. The 833 is lightweight (under 12 pounds/5.5 kg), compact, and portable. Keypad entry and an easy to understand front panel simplify learning to use the 833. A string search function permits automatic examination of stored data.

The 833 Data Comm Tester operates on RS-232, CCITT V.24, or current loop (option) infaces. The 833 can MONITOR the DCE and DTE in synchronous, asynchronous, and HDLC modes. HDLC data streams can be either standard or NRZI-encoded. The 833 can SIMULATE the DCE in synchronous and asynchronous modes and can also calculate and verify CRC-16, CCITT-CRC and LRC-8 block check characters.

For checking modems and phone lines, the 833 features BERT/BLERT capabilities.

ECHO and REPEAT modes are also part of the 833's capabilities.

Built in, self diagnostic routines can assure you at any time that the 833, like the 834 and 832, is operating properly.

833/832 PROM OPTIONS

The 833/832 user PROM feature gives the firstline service force a pre-programmed series of tests. This PROM is user-defined for specific applications so the 833/832 can be customized to fit particular service needs. Use this PROM to perform frequently used standard test sequences, and then, if necessary, create test sequences directly in the 833/832 to make more specific tests and further isolate faults.

Support materials (manuals, user's guides) and video tape training aids are available for all Data Communications Testers.

For more information about how Data Comm Testers can help you identify problems in data communications systems, contact your Tektronix Field Engineer.

In the U.S., write Tektronix, Inc., U.S. Marketing, P.O. Box 1700, Beaverton, OR 97075. In Africa, Europe, Middle East write Tektronix International, Inc., European Marketing Centre, Postbox 827, 1180 AV Amstelveen, The Netherlands. In Asia, Australia, Japan, Central and South America write Tektronix, Inc., Export Marketing, P.O. Box 500, Beaverton, OR 97077.

832

- Microprocessor controlled
- 256 character storage buffer
- Easy to operate key pad
- Portable and lightweight

The TEKTRONIX 832 Data Comm Tester is a portable digital service instrument which can be used to direct the user to possible problems in data communications systems. It can monitor, analyze, test and troubleshoot data communications interfaces that conform to EIA standard RS-232-C, CCITT V.24 or current loop(option). The 832 operates as a serial data transmission monitor or as a modem simulator for off-line testing of data terminal equipment (DTE).

In MONITOR mode the 832 reads and selectively records DTE data and Data Communications Equipment (DCE) data, as well as recording the status of key interface lines.

In SIMULATE mode the 832 simulates the operation of a modem. The 832 can send a message to the DTE and record its response. This data can be sent directly from the 832 or can be transmitted upon receipt of an expected trigger from the DTE.

ECHO mode is the same as SIMULATE, except the 832 sends back to the DTE (echoes) any character sent by the DTE.

In REPEAT mode the 832 can send data repeatedly to the DTE, or the 832 can be programmed to repeat the transmission only upon receipt of an expected trigger from the DTE.

In each of these modes, the 832 can operate at data rates from 50 to 9600 baud; full or half duplex; synchronously or asynchronously; with odd, even or no parity; and with characters from 5 to 8 bits long. HDLC and current loop options are available.

Data Communication Tester

833 / 832 Specifications

ELECTRICAL

Data Transmission Timing — Synchronous and asynchronous.

Communications Mode — Half- or full-duplex.

Bits Per Character — 5, 6, 7, 8, 9. 5 bit/character cannot be selected with parity; 9 bit/character, cannot be selected without parity.

Data Transfer Rates — Internal (crystal controlled) — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, and 4800 bits per second. 9600 bits per second at 8 bits per character, half duplex only. Accuracy — within 0.5%. External — Determined by the DCE or DTE clock.

Parity — Odd, even, or none.

RTS/CTS Delay, (half-duplex mode only) — Programmable from 0 to 255 ms. If not programmed, defaults to 200 ms. Accuracy — Within 1% ±1 ms.

Trigger — Programmable to require a sequence of 1, 2, or 3 characters.

Trigger Position — Location of last trigger character in Receive Buffer: Post Trig, 000; Center, 127; Pre Trig, 255.

832 ONLY

Synchronizing Character (SYN), (synchronous mode only) — Programmable to require one character, or two equal characters. If not programmed, defaults to ASCII SYN character.

Stop Bits (asynchronous mode only) — Responds to one or more. Transmits 2.

833 ONLY

Block Check Characters — CRC-16, CRC-CCITT, LRC.

Synchronizing Character (SYN), (synchronous mode only — Programmable to require one or two characters. If not programmed, defaults to ASCII SYN character.

Stop Bits (asynchronous mode only) — Programmable to 1, 1½, 2.

Bit Error Rate/Block Error Rate Tests — Standard 511-bit pattern stream for 1000-bit blocks; continuous, 10^5 or 10^6-bit block test; stores bits in error, blocks sent, blocks in error, and sync faults.

String Search — Programmable to search for one sequence of 1, 2, or 3 characters.

Full duplex DTE simulation.

BOTH 832/833

RS-232 DCE CONNECTOR (J1405)

Inputs

Pin 3 Received Data, Pin 5 Clear to Send, Pin 6 Data Set Ready, Pin 8 Carrier Detect, Pin 15 Transmission Signal Element Timing (DCE source), Pin 17 Receiver Element Timing (DCE source) —
MARK or OFF: $-25\ V \leq V$ in $\leq +0.75$ V.
SPACE or ON: $+1.5\ V \leq V$ in $\leq +25$ V.
Input Impedance: 3 kΩ $\leq Z$ in $\leq$7 kΩ.

Pin 20 Data Terminal Ready, Pin 24 Transmit Signal Element Timing (DTE source) — MARK or OFF: $-25\ V \leq V$ in ≤ -3 V. SPACE or ON: $+3\ V \leq V$ in $\leq +25$ V. Input impedance with corresponding pin in DTE connector disconnected: Pin 20 Z in $\geq$ 40 kΩ. Pin 24 Z in $\geq$100 kΩ.

Outputs

Pin 2 Transmitted Data, Pin 4 Request to Send —
MARK or OFF: V out ≤ -7.5 V.
SPACE or ON: V out $\geq +7.5$ V.
With load impedance: $R_L \geq 3$ kΩ.

Other

Pin 1 Ground — Connected to pin 1 of DTE connector.

Pin 7 Signal Ground — Connected to instrument ground.

Pins 9 thru 14, 16, 18, 19, 21 thru 23, and 25 — Connected through switches (Breakout Panel DIP switches) to their corresponding pins in the DTE connector.

RS-232 DTE CONNECTOR (J2005)

Inputs

Pin 2 Transmitted Data, PIn 4 Request to Send —
MARK or OFF: $-25\ V \leq V$ in $\leq +0.75$ V.
SPACE or ON: $+1.5\ V \leq V$ in $\leq +25$ V.
Input impedance: 3 kΩ $\leq Z$ in $\leq$7 kΩ.

Pin 20 Data Terminal Ready, Pin 24 Transmit Signal Element Timing (DTE source) — MARK or OFF: $-25\ V \leq V$ in ≤ -3 V. SPACE or ON: $+3\ V \leq V$ in $\leq +25$ V Input impedance with corresponding pin in DCE connector disconnected: Z in $\geq$100 kΩ.

Outputs

Pin 3 Received Data, Pin 5 Clear to Send, Pin 6 Data Set Ready, Pin 8 Carrier Detect, Pin 15 Transmission Signal Element Timing (DCE source), Pin 17 Receiver Signal Element Timing (DCE source) —
MARK or OFF: V out ≤ -7.5 V.
SPACE or ON: V out $\geq +7.5$ V.
With load impedance: $R_L \geq 3$ kΩ.

Other

Pin 1 Ground — Connected to pin 1 of DCE connector.

Pin 7 Signal Ground — Connected through a switch (Breakout Panel DIP switch) to instrument ground.

Pin 9 thru 14, 16, 18, 19, 21 thru 23, and 25 — Connected through switches (Breakout Panel DIP switches) to their corresponding pins in the DCE connector.

BREAKOUT PANEL

Probe —
Space: $+3\ V \leq V$ in $\leq +25$ V.
Mark: $-25\ V \leq V$ in ≤ -3 V.
Input Impedance: $\geq$50 kΩ.

Marker — MARK or OFF: $-25\ V \leq V$ in ≤ -3 V. SPACE or ON: $+3\ V \leq V$ in $\leq +25$ V (Schmitt input).

+12 Volt Source — +12 V ±1 V (no load). Output impedance approx 3 kΩ (each pin).

DISPLAY

Buffer Content — 2 hexadecimal digits: 7-segment, LED displays.

Buffer Location — 3 decimal digits: 7-segment, LED displays.

Data Source — DCE, DTE: 2 LED indicators.

Error — Parity, Frame: 2 LED indicators.

No Trig, No Syn — 2 LED indicators.

RS-232 Control Lines — DSR, CD, CTS, RTS, DTR, and and MARKER: 6 LED indicators.

Probe — Mark, Space: 2 LED indicators.

PHYSICAL CHARACTERISTICS

Dimensions (approx)	in	cm
Width	13	33
Height	4	10
Length	12	31
Weight	**lb**	**kg**
Net	11	5

MEMORY

Receive buffer is 256 characters and send buffer is 255 characters. Basic instrument contains in memory a group of 7 separate standard test messages such as "THE QUICK BROWN FOX —" and the full ACII Alphanumeric set.

There is provision in the 832/833 for installation of user defined and programmed EPROMs containing messages specific to particular tests. A total memory space of 2048 characters is available for user specification.

POWER REQUIREMENTS

Line Voltage Ranges —
115 V — 90 to 132 V.
230 V — 180 to 250 V.

Line Frequency Range — 48 to 440 Hz.

Power Consumption — Approx 15 watts.

ENVIRONMENTAL

Temperature — Operating: 0° to +50°C (+32° to +122°F). Nonoperating: −55° to +75°C (−67° to +167°F).

Humidity — 5 cycles (120 hrs), 30° to 60°C, 95% relative humidity.

Altitude — Operating: To 15,000 feet (4500 m). Nonoperating: To 50,000 feet (15,000 m).

Vibration — Cycle the vibration frequency from 10 to 55 to 10 Hz (linear or logarithmic sweep) for a duration of 15 minutes in each major axis at a displacement of 0.025 inches (0.64 mm) peak to peak. Dwell for 10 minutes in each major axis at any resonant frequency.

Shock — 50 g's, ½ sine, 11 ms duration, three shocks in each major axis for a total of 18 shocks.

INCLUDED ACCESSORIES

832

RS-232 cable assembly (012-0815-00), jumper set (198-4006-00), power cord (161-0066-00).

833

RS-232 cable assembly (012-0815-00), jumper set (198-4006-00), power cord (161-0066-00), Y-connector (012-0893-00).

832 ORDERING INFORMATION

832 Data Comm Tester $1995

INSTRUMENT OPTIONS

DATA SPEED 40 ROM Option 0A ..... Add $210
IBM 3270 Exersizer ROM Option 0B $210
Current Loop Interface Option 02 ..... $300
High-Level Data Link Control (HDLC) Option 03 ..... Add $325

OPTIONAL ACCESSORIES

Self Test Adapter — 067-0878-00 ..... $100
Diagnostic ROM Pack 067-0986-00 ..... $480
Carrying Case — 016-0672-00 ..... $70

833 ORDERING INFORMATION

833 Data Comm Tester $2,750
DATA SPEED 40 ROM Option 0A $210
IBM 3270 Exersizer ROM Option 0B ..... Add $210
Current Loop Interface Option 02 ..... Add $300

OPTIONAL ACCESSORIES

Self Test Adapter — 067-0878-00 ..... $100
Current Loop Pod Accessory — 015-0361-00 .... $325
Diagnostic ROM Pack 067-0986-00 ..... $480
Carrying Case — 016-0672-00 ..... $70

830 SERIES
Product Line Comparison

	832	833	834
Operation Modes			
Monitor	Yes	Yes	Yes
DCE simulate	Yes	Yes	Yes
DTE simulate	No	Yes (FDX only)	Yes
BERT/BLERT	No	Yes	Yes
Echo	Yes	Yes	No
Repeat	Yes	Yes	Yes
Self Test	Functional	Functional	Functional & Diagnostic
Protocol Test	Minimal	Minimal	Fixed Sequence
Current Loop	Option	Option/Accessory	Option/Accessory
Maximum Data Transfer Rate	9.6K baud	9.6K baud	19.2K baud
Separate Transmit/Receive Rates	No	No	Yes
Memory			
Receive buffer (char)	256	256	2699
Send buffer (char)	255	255	3000
User PROM (char)	2048 (data only)	2048 (data only)	16K (data or program sequence)
Receive buffer search	No	Yes	Yes
Display			
No. of characters & type	3 add + 2 data 7 segment LED	3 add + 2 data 7 segment LED	12 data & scratch pad 5x7 matrix LED
Character set	Hex	Hex	Hex, ASCII, EBCDIC, User defined (option)
Operating Controls			
Operator menu	No	No	Yes
Programmed sequences	No	No	Yes (manual or down load)
Initialization	Fixed default or manual	Fixed default or manual	Fixed default, program initialization, manual
Programmable timeout	No	No	Yes
Triggering/Trapping			
Strings	3 characters	3 characters	1-5 characters (non-masked) 1-25 characters (masked)
Errors	No	No	Yes
Events	No	No	Yes
Error Check			
Parity check	Yes	Yes	Yes
Frame check	Yes	Yes	Yes
Block check function			
Generate	No	Yes	Yes
Check	No	Yes	Yes
Type	None	CRC 16, CRC-CCITT	LRC, CRC-16 CRC-CCITT
Programmable:	No	No	Yes
Stored programs	No	No	99 steps
Stored messages	255 characters	255 characters	3000 char.
Recallable keystroke sequences	No	No	Yes
Net Weight	11 lb	11.5 lb	12 lb
Price	**$1995**	**$2750**	**$3700**

Digital Tester

851

Designed for Digital Field Service Applications

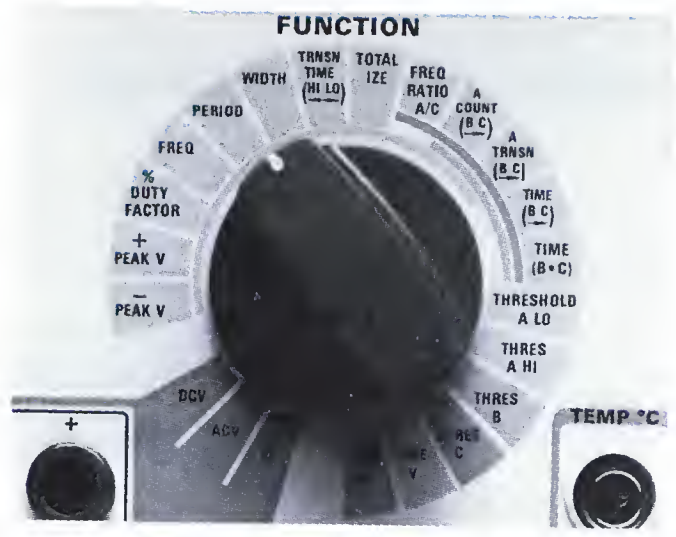
Small and Lightweight

The 851 Digital Tester is an easy-to-operate first-line service tool used to troubleshoot and maintain a wide range of digital equipment.

With this portable digital tester (only 13 pounds, 6 kg), a first-line service engineer can make many of the same measurements that now require an oscilloscope, DMM, counter, timer, logic probe, thermometer and special purpose test equipment.

One knob lets you dial 22 functions to perform a wide variety of tests and measurements. Eleven functions measure timing, two register plus and minus peak voltages, three carry out DMM measurements through separate leads and one reads line voltage at the outlet. Another function allows you to take temperature readings with an optional temperature probe. The 851 also measures its four input thresholds to adjust to the logic levels of the equipment being serviced.

All the functions are completely autoranging and the indicator lights tell you exactly what range is being used.



SPECIFICATIONS

INPUTS

(ACV, DCV, Ω)

Resistance and Capacitance — 10 MΩ ±1% and approx 100 pF. Red to black terminal. (Volts only)

Max Safe Input Voltage — (≤1 kHz)

Resistance

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ, and 50 MΩ.

AC VOLTS

(Average responding RMS calibrated for sine wave.)

Ranges — 2 V, 20 V, 200 V, and 350 V.

Accuracy —

2 V and 20 V:
±0.5% or reading ±4 counts, 40 Hz to 1 kHz.
±2% of reading ±4 counts, 1 kHz to 25 kHz.
>9% full scale.

200 V and 350 V:
±0.5% of reading ±4 counts, 40 Hz to 1 kHz.

Extended temperature range: add ±0.2%.

DC VOLTS

Ranges — 2 V, 20 V, 200 V, and 500 V.

Accuracy —

2 V, 20 V and 200 V: ±0.1% of reading ±3 counts.
500 V: ±0.15% of reading ±3 counts.
Extended temperature range: add ±0.05%.

LINE VOLTAGE

Range — 90 to 132 V and 180 to 250 V.

Accuracy — ±3% of reading.

TEMPERATURE

Range — −55° to +150°C.

Accuracy — ±2°C (0.01° resolution). Extended temperature range: add ±1°C.

INPUTS

(3 probes; one for each channel A, B, C.)

Resistance and Capacitance — 10 MΩ and approx 12 pF.

Max safe input voltage — ±500 V at probe tip (≤50 kHz)

Threshold Levels

Variable (4 controls) range: ±30 V; setability ±10 mV.

TTL (nominal, in detent position) — Input A LO + 0.7 V; HI + 2.1 V; Input B and C + 1.4 V.

Input Filter

(Narrow pulse rejection) max input rep rate for pulse rejection = 20 MHz.

Range — off and 50 ns ±20% to >300 ns.
Channel to channel delay mismatch: <100% of setting.

POSITIVE AND NEGATIVE PEAK VOLTS

Range — ±30 V.

Accuracy — ±2% of reading ±3% of p-p signal ±90 mV. Max time between recurrent peaks, 25 ms. Peak amplitude must be maintained for at least 25 ns. Extended temperature range: add ±1% of reading ±1% of p-p signal ±10 mV.

FREQUENCY

Ranges — 100 kHz (1 Hz resolution), 1 MHz, 10 MHz, and 35 MHz.

Accuracy — ±0.005% of reading ±1 count.

TIME MEASUREMENTS

(Period, pulse width, transition time, time interval, and coincidence time.)

Ranges — 1 ms (10 ns resolution), 10 ms, 100 ms, 1 s, and 10 s.

Minimum Time Interval — 20 ns.

Accuracy — ±0.005% of reading ±1 count ± Trigger Error.

COUNTING

(Totalize, frequency ratio, events count, and transitions count.)

Range — 0 to 99,999.

Max Input Frequency — 35 MHz (except 17.5 MHz for transition counting).

Accuracy — ±1 count, ±A Input event or transition frequency multiplied by the Time Interval Trigger Error.

DUTY FACTOR

Range — 0 to 100%.

Input Freq Range — 40 Hz to 10 MHz.

Min pulse width (HI and LO portions) — 50 ns.

READOUT

Type — 5 digits, fully buffered 7 segment, 0.5″ LEDs.

Polarity Indication — + for positive readings, − for negative readings.

Overrange Indication — Display flashes.

Range Indicators — LEDs show function ranges in Ω, kΩ, MΩ, MHz, kHz, ms, μs and V.

Logic State Indicators — Red, yellow, and green LEDs show valid and invalid logic state inputs for CH A. Red and green LEDs show logic states above or below the threshold set for CH B and C. Any state change indication is sustained long enough to be visible.

Threshold Lock Indicator (LO > HI) — Red LED indicates when CH A LO and HI thresholds are locked together (LO threshold setting is higher than the HI setting).

PHYSICAL CHARACTERISTICS

Dimensions (approx)	in	cm
Width	13	33
Height	12	31
Depth	7	18
Weight	**lb**	**kg**
Net	13	6

POWER REQUIREMENTS

Line Voltage Range — 90 to 132 V or 180 to 250 V.

Frequency — 48 Hz to 440 Hz.

Power Consumption — 57 watts max.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: +15°C to +40°C. Nonoperating: −40°C to +75°C. Extended operating range: +5°C to +50°C.

Altitude — Operating: to 10,000 ft. Nonoperating: to 35,000 ft.

Vibration — Operating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. After cycle vibration in each axis, hold frequency steady at 55 Hz for 10 minutes. All major resonances must be above 55 Hz.

Humidity — To 90% at 30°C Tektronix Test Method #1 90% relative humidity at 30°C for 4 hours.

Shock — Two shocks at 30 g's, ½ sine, 11 ms duration, each direction along each major axis. Total of 12 shocks.

EMC — Reference Mil Standard 461A-462 susceptibility as specified. Conducted emission, relax 10 dB. Radiated emission, relax 15 dB <100 MHz and relax 25 dB ≥100 MHz.

INCLUDED ACCESSORIES

Three signal probes (010-0280-00), two DMM probes (012-0732-00).

ORDERING INFORMATION

851 Digital Tester $2430

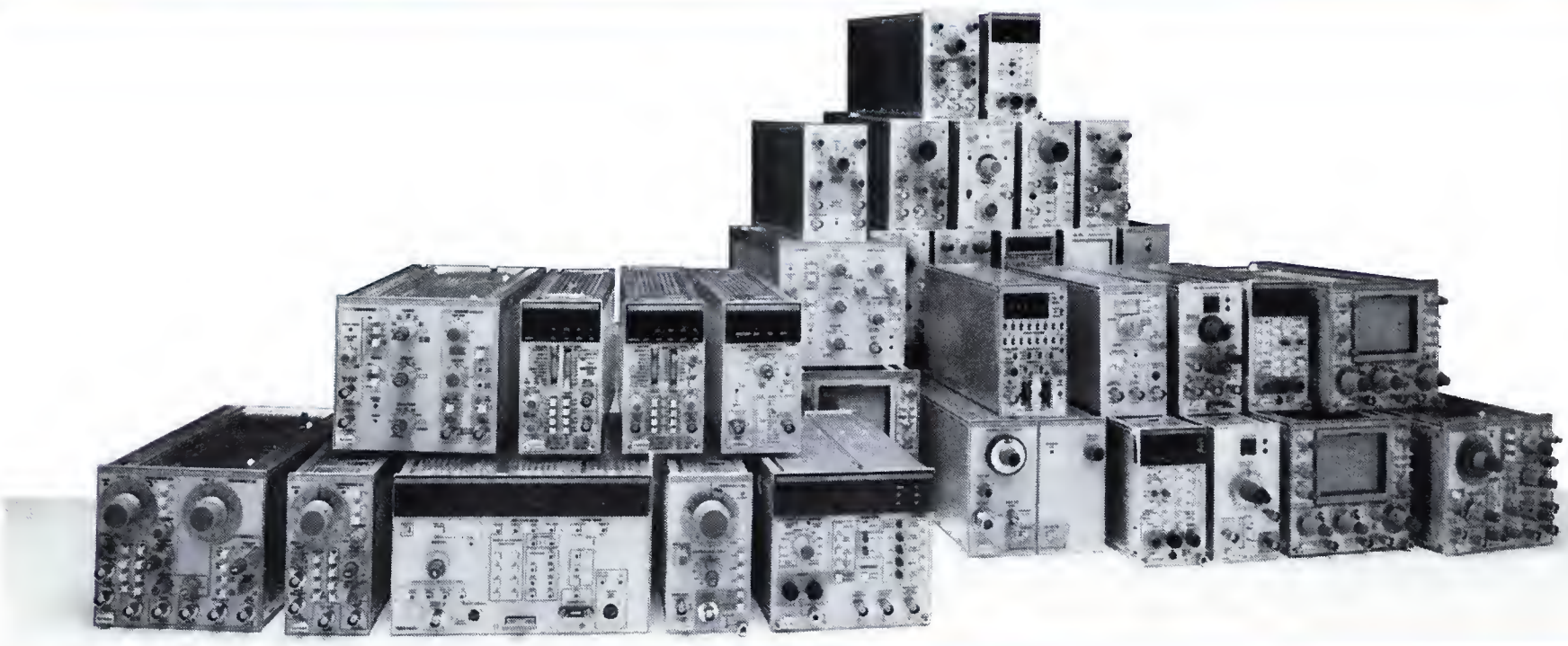
INSTRUMENT OPTION

Option 01 (with temperature probe) ..... Add $160

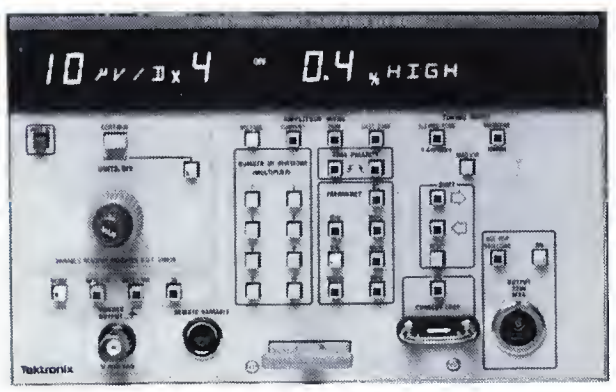
OPTIONAL ACCESSORIES

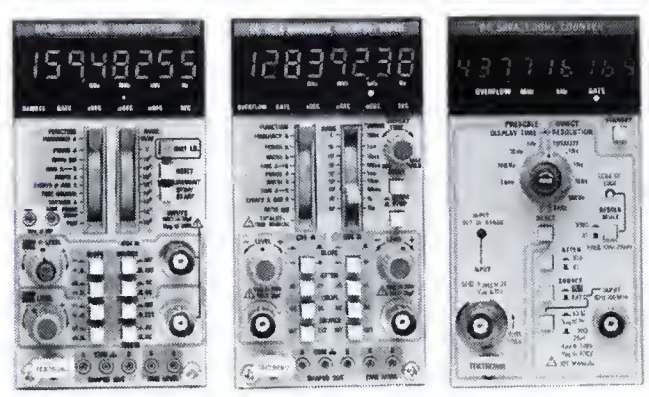
Temperature Probe — 010-6430-00 ..... $160
Rain Jacket — 016-0639-00 ..... $15
Diagnostic ROM Pack 067-0986-00 ..... $480

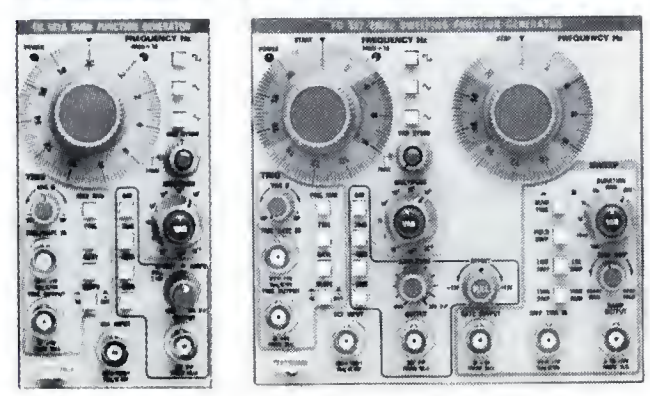
TM 500 Test & Measurement Instruments



NEW







Eight new plug-ins greatly expand your performance selection within the TM 500 line of configurable test and measurement instruments.

Three new digital counters, the DC 503A, DC 509 and DC 508A represent significant performance improvements in the TM 500 digital counter offering. The DC 509 is a highly flexible and accurate counter with bandwidth of 135 MHz. The DC 503A is a 125 MHz counter offering improved general-purpose performance features. The DC 508A is a 1.3 GHz counter specifically appropriate for very high frequency applications, as in two-way radio testing.

In the pulse generator area, the new PG 507 offers 50 MHz bandwidth combined with dual output capability.

The FG 507 is a 2 MHz Function Generator with linear and log sweep capability; ideal for audio and other low distortion applications. The FG 501A is a deluxe 2 MHz full featured, low frequency and low distortion function generator.

The AA 501 Distortion Analysis provides a fully automatic approach to making complex distortion measurements. And, with 0.0025% residual distortion the AA 501 clearly is capable of state-of-the-art performance.

For large-scale oscilloscope calibration applications, TM 500 introduces the CG 551AP. The CG 551AP is fully programmable via the IEEE-488 bus and provides state-of-the-art calibration standards.

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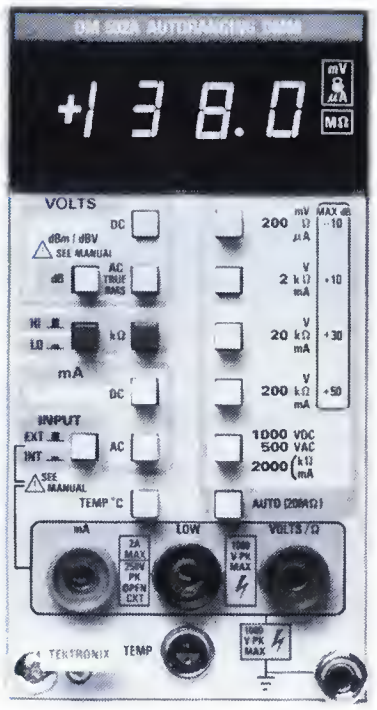
Digital Multimeters

TM 500 Digital Multimeters offer a compact solution to your measurement needs without compromising wide performance range. The DM 502A, the DM 501A and DM 505 offer accuracy and flexibility in laboratory, bench, field service and maintenance applications.

The DM 501A gives 4½ digits of readout resolution. And seven distinct measurement functions, with 0.05% dc volts accuracy and true RMS capability. The DM 502A adds testing convenience through autoranging. Seven full functions are displayed on 3½ digits. The DM 505 provides five functions for all-around testing at low cost.

Configurability is the watchword for the TM 500 family. The DM 505, DM 501A, and the DM 502A, along with these other TM 500 plug-ins: digital counters, pulse generators, function generators, amplifiers, signal processors, audio oscillator, ramp generator, calibration instruments, power supplies, oscilloscopes, digital delay, word recognizer and digital latch, can be configured in any of six compact mainframes. The mainframes, holding from one to six plug-ins, can be racked, stacked, rolled to the application site or handcarried. The TM 515 Traveler Mainframe looks like a piece of carry-on flight luggage.

With full-scale precision measuring capabilities, backed by Tektronix design and engineering expertise, the DM 505, DM 502A and the DM 501A, are designed for almost any test and measurement application.



DM 502A

Digital Multimeter

DM 502A

True RMS

Autoranging

Seven Functions including Temperature and dB

0.1% Dc Volts Accuracy

3½ Digits

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random or other non-sinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 V-0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. The high voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3½ digit display.

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 1000 V. Automatic or manual ranging.

Accuracy — 18°C to 28°C:

200 mV to 200 V Ranges	±[0.1% of reading +0.05% of full scale (1 count)]
1000 V Range	±[0.1% of reading +0.05% of full scale (1 count)]

0°C to 18°C and 28°C to 50°C:

200 mV to 200 V Ranges	±[0.2% of reading +0.1% of full scale (2 counts)]
1000 V Range	±[0.2% of reading +0.2% of full scale (2 counts)]

Common-Mode Rejection Ratio — ≥100 dB at dc. ≥80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ≥50 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 100 μV.

Step Response Time — 1 s within a range, +1.5 s for each range change in autoranging mode.

Input Resistance — 10 MΩ.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V. Automatic or manual ranging (ac coupled).

Accuracy

18°C to 28°C:

	20 Hz	40 Hz	20 kHz
200 mV to 200 V Ranges	±[1.5% of reading +0.3% of full scale (6 counts)]		±[0.6% of reading +0.3% of full scale (6 counts)]
500 V Range	±[1.5% of reading +1.2% of full scale (6 counts)]		±[0.6% of reading +1.2% of full scale (6 counts)]

0°C to 18°C and 28°C to 50°C:

	20 Hz	40 Hz	20 kHz
200 mV to 200 V Ranges	±[1.8% of reading +0.35% of full scale (7 counts)]		±[0.8% of reading +0.35% of full scale (7 counts)]
500 V Range	±[1.8% of reading +1.4% of full scale (7 counts)]		±[0.8% of reading +1.4% of full scale (7 counts)]

Typically usable to 100 kHz.

Common-Mode Rejection Ratio — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 100 μV.

Response Time — 1 s within a range, +1.5 s for each range change in autoranging mode.

Input Impedance — 10 MΩ paralleled by <100 pF.

Maximum Input Voltage — 500 V ac RMS. 600 V dc, not to exceed 1000 V peak.

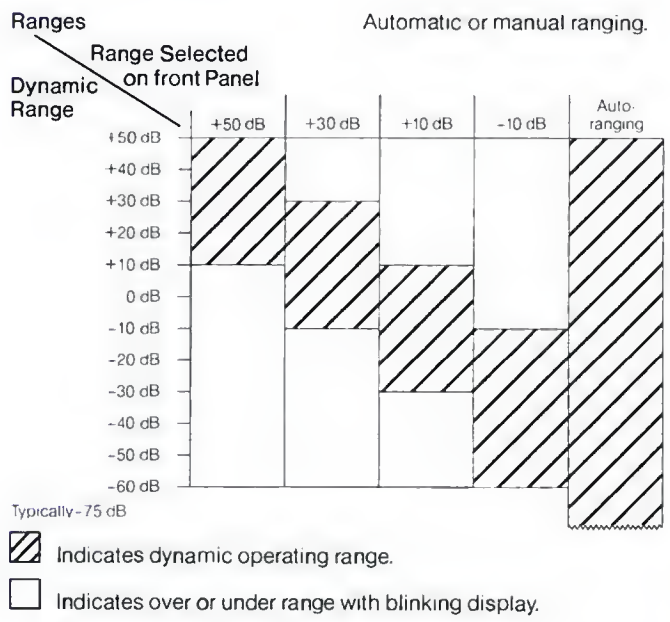
Crest Factor — 4 at full scale all ranges (≤2 on 500 V range).

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm). Internal jumper change for zero dB reference of 1.000 V (dBV).

TM 500 DIGITAL MULTIMETER SELECTION CHART

Model Number	Number of Digits	Number of Functions	DC Volts			AC Volts			AC+DC Current	dB	Ohms (HI-LO)	Temp	True RMS	Auto Range
			Ranges	Accuracy	Best Resolution	Ranges	Accuracy	Best Resolution	Ranges	Ranges	Ranges	Range		
DM 501A	4½	7	200 mV to 1000 V	±0.05%	10 μV	200 mV to 500 V	±0.6%	10 μV	200 μA to 2 A	+54 dB to −60 dB	200 Ω to 20 MΩ	−62°C to +240°C	X	
DM 502A	3½	7	200 mV to 1000 V	±0.1%	100 μV	200 mV to 500 V	±0.6%	100 μV	200 μA to 2 A	+50 dB to −60 dB	200 Ω to 20 MΩ	−55°C to +200°C	X	X
DM 505	3½	5	200 mV to 1000 V	±0.1%	100 μV	200 mV to 500 V	±0.5%	100 μV	200 μA to 2 A		200 Ω to 2 MΩ			



Accuracy

	20 Hz	2 kHz	10 kHz	20 kHz
+50 dB to −50 dB	±0.5 dB			
−50 dB to −60 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB	

*From 0°C to 18°C and 28°C to 50°C, add 0.6 dB to above accuracy specifications. For example, at 0°C the accuracy in the +50 dB to −50 dB range from 20 Hz to 20 kHz would be ±1.1 dB.

Noise Level — Typically −75 dB.

Maximum Resolution — 0.1 dB.

Response Time — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.

Input Impedance — 10 MΩ paralleled by <100 pF.

Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak.

Crest Factor — 4 at full scale (≤2 above 40 dB).

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ. Automatic or manual ranging.

Accuracy — 18°C to 28°C:

200 Ω to 2000 kΩ Ranges	±[0.5% of reading +0.05% of full scale (1 count) +0.2 Ω]
20 MΩ Range	±[1% of reading +0.05% of full scale (1 count)]

0°C to 18°C and 28°C to 50°C:

200 Ω to 2000 kΩ Ranges	±[0.8% of reading +0.1% of full scale (2 counts) +0.2 Ω]
20 MΩ Range	±[1.3% of reading +0.1% of full scale (2 counts)]

Response Time — ≤1 s within a range, ≤1.5 s for each range change in autoranging mode.

Maximum Input Volts — 130 V dc or ac RMS indefinitely. 230 V dc or ac RMS for 30 minutes maximum.

HI-LO Ohms Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Resolution — 0.1 Ω.

Maximum Open-Circuit Voltage Developed — Approximately 14 V.

DC AND TRUE RMS AC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA. Manual ranging only.

Accuracy —

Dc Current Only:

18°C to 28°C: ±[0.2% of reading +0.05% of full scale (1 count)].

0°C to 18°C and 28°C to 50°C: ±[0.3% of reading +0.1% of full scale (2 counts)].

Ac Current Only (from 40 Hz to 10 kHz)

18°C to 28°C: ±[0.6% of reading +0.3% of full scale (6 counts)].

0°C to 18°C and 28°C to 50°C: ±[0.7% of reading +0.5% of full scale (10 counts)].

Usable to 20 kHz.

Input Resistance — Range	Approx Resistance
200 μA	1 kΩ
2 mA	100 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Response Time — ≤1 s.

Maximum Open Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage — 1000 V peak.

Maximum Resolution — 0.1 μA.

TEMPERATURE

Range — −55°C to +200°C.

Resolution — 0.1°C.

Accuracy — +18°C to +28°C ambient temperature*

Temperature to be Measured

	−55°C	+150°C	+200°C
P6601 Probe and DM 502A calibrated as a pair	±2.5°C		±3.5°C
P6601 and instrument not calibrated as a pair	±4.5°C		±5.5°C

*For 0°C to +18°C and 28°C to 50°C ambient temperatures, add ±1.5°C to accuracy specifications.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except 1000 V dc and 500 V ac).

Measurement Rate — 3 per second.

Power Consumption — Approximately 8 watts.

Inputs — Maximum input voltage is 1000 V. The front panel volts/Ω, or LOW, or mA terminal can be floated 1000 V peak max above ground, the rear input 200 V peak. For the rear input, ac volts, ohms and maximum input specifications are derated.

Included Accessories — One pair test leads 003-0120-00, one P6601 Temperature Probe 010-6601-01.

ORDERING INFORMATION

DM 502A **$550**

Option 02 (Deletes temperature probe and capability) ..... **Sub $125**

P6601 TEMPERATURE PROBE

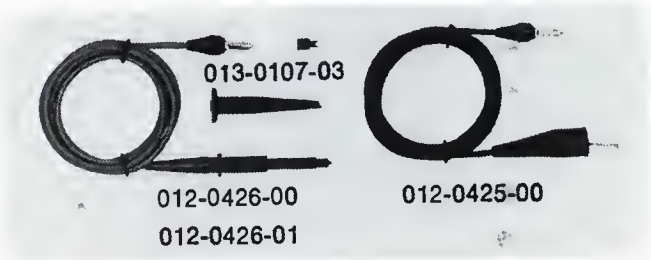
The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the sensing element to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 s ±0.2 s. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a max of 240°C, and cable is limited to a max of 140°C.

Order P6601 Temperature Probe
010-6601-01 ..... **$160**

OPTIONAL ACCESSORIES

The following accessories may be ordered as options for use with any of the three TM 500 Digital Multimeters.



Test Lead, Black, 4 ft **012-0425-00** **$8**
Test Lead, Red, 4 ft **012-0426-00** **$12.50**
Test Lead, Black, 4 ft **012-0426-01** **$12.50**
Test Lead Set of 012-0425-00, 012-0426-00, and 013-0107-03 **012-0427-00** **$21**

High Voltage Probe to 40 kV
Order 010-0277-00 ..... **$105**
For Complete Information see page 222.

P6420 RF Probe, 2 m Cable included
Order 010-6420-03 ..... **$10**
For Complete Information see page 274.

Female BNC to dual banana adapter
Order 103-0090-00 ..... **$7.50**

ENVIRONMENTAL SPECIFICATIONS

The following environmental specs are common to all three digital multimeters.

Temperature — Operating in mainframe: 0°C to 50°C. Non-operating: −55°C to +75°C. MIL-T-28800B Class 5.

Humidity — 95% to 100% for 5 days (derated above 25°C). MIL-T-22800B, Class 5.

Altitude — Operating in mainframe: to 15,000 ft. (4.6 km). Non-operating: to 50,000 ft. (15 km), MIL-T-28800B, Class 3.

Vibration — In TM 515 Mainframe: 0.38 mm (0.015 in) displacement 1 to 55 Hz sinewave for 75 minutes MIL-T-28800B, Class 5. In TM 501, TM 503, TM 504, or TM 506 mainframe: 0.26 mm (0.010 in) displacement, 10-55 Hz sinewave. 75 minutes total.

Without mainframe: MIL-T-28800B. Class 3: 0.060 in 5-10 Hz, 0.040 in 5-25 Hz, 0.020 in 25-55 Hz.

Shock — Operating in TM 515 Mainframe: 30 g's, ½ sine, 11 ms duration, 18 shocks, MIL-T-28800B, Class 5. Operating in TM 501, TM 503, TM 504, or TM 506 mainframe: 20 g's, ½ sine, 11 ms duration, 18 shocks.

Without mainframe: MIL-T-28800B, Class 3; 30 g's, ½ sine, 11 ms duration, 18 shocks.

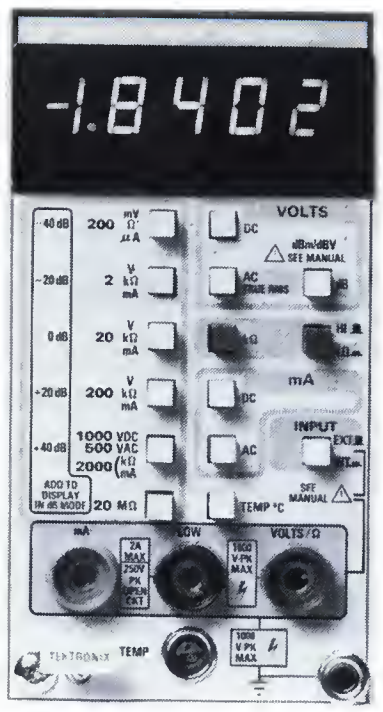
Bench Handling — Drop from Operating 45° or 4 in or equilibrium, whichever occurs first. MIL-T-28800B, Class 3.

Electromagnetic Compatibility — Operating in mainframe 30 Hz to 1 GHz: MIL-T-28800B, Class 3.

Electrical Discharge — Operating in mainframe 20 kV max. No MIL-T-28800B equivalent. Charge applied to each protruding area of the front panel except input terminals.

Transportation — Vibration: 25 mm (1 inch) at 270 rpm for 1 hour without mainframe; National Safe Transit Association Preshipment Test. Package Drop: 10 drops from 91 cm (3 feet) without mainframe.

Tektronix offers maintenance training classes on the TM 500 Calibration Systems Package and a new multi-media training package on Digital Counter and Meter Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.



Digital Multimeter

DM 501A

0.05% dc Voltage Accuracy

Seven Functions

dB

4½ Digits

True RMS

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB and temperature. The DM 501A gives 4½ digits of readout resolution. All with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted wave forms. DB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the TEKTRONIX P6601 platinum film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds.

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 1000 V.

Accuracy

18°C to 28°C:

200 mV Range	±[0.05% of reading +0.015% of full scale (3 counts)]
2 V to 200 V Ranges	±[0.05% of reading +0.01% of full scale (2 counts)]
1000 V Range	±[0.05% of reading +0.02% of full scale (2 counts)]

0°C to 18°C and 28°C to 50°C:

200 mV to 200 V Ranges	±[0.1% of reading +0.025 of full scale (5 counts)]
1000 V Range	±[0.1% of reading ±0.05% of full scale (5 counts)]

Common-Mode Rejection Ratio — ≥100 dB at dc. ≥80 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ≥60 dB at 50 Hz or 60 Hz ±0.2 Hz.

Maximum Resolution — 10 μV.

Step Response Time — ≤1 second.

Input Resistance — 10 MΩ.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS

Input signal must be between 5% and 100% of full scale.

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V (ac coupled).

Accuracy — 18°C to 28°C:

	20 Hz	40 Hz	10 kHz	20 kHz
200 mV to 200 V Ranges	±[1% of reading +0.05% of full scale (10 counts)]	±[0.6% of reading +0.05% of full scale (10 counts)]	±[1% of reading +0.05% of full scale (10 counts)]	
500 V Range	±[1% of reading +0.2% of full scale (10 counts)]	±[0.6% of reading +0.2% of full scale (10 counts)]	±[1% of reading +0.2% of full scale (10 counts)]	

0°C to 18°C and 28°C to 50°C:

	20 Hz	40 Hz	10 kHz	20 kHz
200 mV to 200 V Ranges	±[1.3% of reading +0.075% of full scale (15 counts)]	±[0.8% of reading +0.075% of full scale (15 counts)]	±[1.3% of reading +0.075% of full scale (15 counts)]	
500 V Range	±[1.3% of reading +0.3% of full scale (15 counts)]	±[0.8% of reading +0.3% of full scale (15 counts)]	+[1.3% of reading +0.3% of full scale (15 counts)]	

Common-Mode Rejection Ratio — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 10 μV.

Response Time — <2 seconds.

Input Impedance — 10 MΩ paralleled by 160 pF.

Maximum Input Voltage — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

Crest Factor — 4 at full scale.

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm) Internal jumper change for zero dB reference of 1.0000 V (dBV).

Accuracy — 18°C to 28°C*

	20 Hz	2 kHz	10 kHz	20 kHz
+20 dB to −15 dB	±0.5 dB			
−15 dB to −20 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB	

*From 0°C to 18°C and 28°C to 50°C, add 0.6 dB to above accuracy specifications.

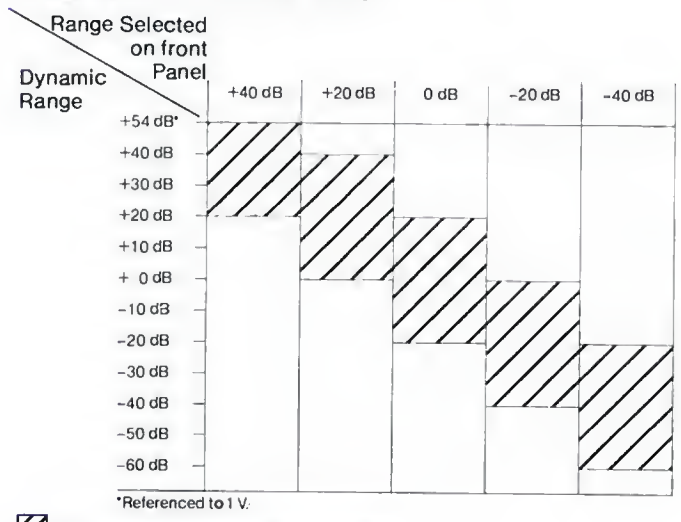
Maximum Resolution — 0.1 dB.

Response Time — <2 seconds.

Input Impedance — 10 MΩ paralleled by <160 pF.

Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak. Equivalent to +54 dBV or +56.2 dBm.

Crest Factor — 4 at full scale.



▨ indicates dynamic operating range

□ indicates out of range with blinking display

To obtain the correct dB reading, algebraically add the range selected to the display reading ("dynamic range" should be ±20 dB from range reflected on front panel except +54 dB).

RESISTANCE

Response Time — <2 sec in 200 Ω to 2000 kΩ ranges; <10 sec in 20 MΩ range.

Maximum Input Volts — 250 V peak.

Maximum Resolution — 10 mΩ.

HI-LO OHM Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Open-Circuit Voltage Developed — <6 V.

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ.

Accuracy — 18°C to 28°C:

200 Ω Range	LO Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2 kΩ to 2000 kΩ Ranges	HI Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2 kΩ to 200 kΩ Ranges	LO Ω	±[0.15% of reading +0.015% of full scale (3 counts)]
2000 kΩ Range	LO Ω	±[0.3% of reading +0.015% of full scale (3 counts)]
20 MΩ Range	HI Ω only	±[0.5% of reading +0.015% of full scale (3 counts)]

0°C to 18°C and 28°C to 50°C:

200 Ω Range	LO Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
2 kΩ to 2000 kΩ Ranges	HI Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
2 kΩ to 200 kΩ Ranges	LO Ω	±[0.3% of reading +0.025% of full scale (5 counts)]
20 MΩ Range 2000 kΩ Range	HI Ω only LO Ω	±[1.2% of reading +0.025% of full scale (5 counts)]

DC AND TRUE RMS AC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.

Accuracy —

Dc Current only:

18°C to 28°C — ±[0.2% of reading +0.015% of full scale (3 counts)].

0°C to 18°C and 28°C to 50°C — ±[0.3% of reading +0.025% of full scale (5 counts)].

Ac Current only: (from 20 Hz to 10 kHz):

Input signal must be between 5% and 100% of full scale.

18°C to 28°C — ±[0.6% of reading +0.05% of full scale (10 counts)].

0°C to 18°C and 28°C to 50°C — ±[0.7% of reading +0.075% of full scale (15 counts)]. Usable to 20 kHz.

Response Time — <1 sec dc current, <2 sec ac current.

Input Impedance —

Range	Approx. Resistance
200 μA	1.0 kΩ
2 mA	100 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Maximum Open-Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage — 1000 V peak.

Maximum Resolution — 10 nA.

TEMPERATURE

Range — −62°C to +240°C.

Resolution — 0.1°C.

Accuracy — 18°C to 28°C ambient temperature.*

Temperature to be measured

	−62°C	+150°C	+240°C
P6601 and DM 501A calibrated as a pair	±2°C	+0° C to −6°C	
P6601 and instrument not calibrated as a pair.	±4°C	+2°C to −8°C	

***For 0°C to 18°C and 28°C to 50°C ambient temperatures, add 1.5°C to above limit in each direction.**

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except on 1000 V dc and 500 V ac ranges).

Measurement Rate — 3⅓ per second.

Power Consumption — Approximately 9 watts.

Inputs — Maximum input voltage is 1000 V. The front panel Volts/, or LOW, or mA terminals can be floated to 1000 V peak max. above ground, the rear input only 200 V peak. For the rear input, ac volts, ohms, and maximum input specifications are derated.

INCLUDED ACCESSORIES

One pair of test leads 003-0120-00; one P6601 Temperature Probe 010-6601-01.

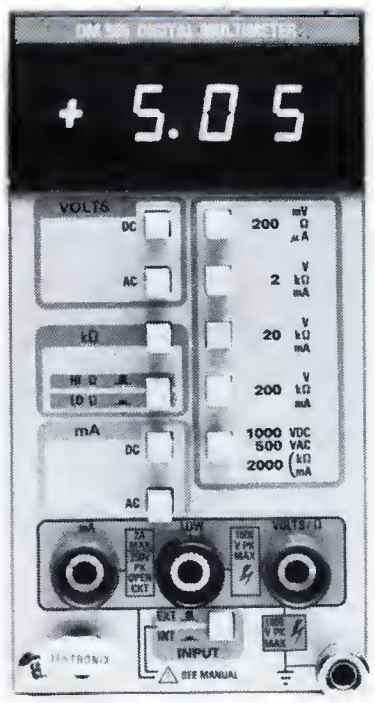
For environmental specifications and accessories see page 187.

ORDERING INFORMATION

DM 501A Digital Multimeter $600

Option 02 (deletes P6601 Temperature Probe and temperature measurement capability) . . . Sub $125

DM 505



Digital Multimeter

DM 505

3½ Digit LED Display

Five Basic Functions

0.1% dc Volts Accuracy

The DM 505 Digital Multimeter measures five standard functions: resistance, dc or ac volts and dc or ac current. All functions and ranges are pushbutton selectable. A bright 3½ digit display makes measurements easy to read. In the resistance mode, a high (2 V) or low (0.2 V) probe tip voltage is available. The low probe tip voltage is useful for making in-circuit measurements without forward-biasing silicon diode and transistor junctions. In ac modes, the DM 505 responds to the average value of the ac current or voltage input and displays the equivalent RMS value.

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 1000 V.

Accuracy — 18°C to 28°C:

200 mV to 200 V Ranges	±[0.1% of reading +0.05% of full scale (1 count)]
1000 V Range	±[0.1% of reading +0.1% of full scale (1 count)]
0°C to 18°C and 28°C to 50°C:	
200 mV to 200 V Ranges	±[0.2% of reading +0.1% of full scale (2 counts)]
1000 V Range	±[0.2% of reading +0.2% of full scale (2 counts)]

Common-Mode Rejection Ratio — ≥100 dB at dc, ≥80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ≥50 dB at 50 Hz or 60 Hz, ±0.2 Hz.

Maximum Resolution — 100 μV.

Step Response Time — ≤0.5 s to rated accuracy.

Input Resistance — 10 MΩ ±0.5%.

Maximum Input Voltage — 1000 V peak.

AC VOLTS

Average responding ac volts, calibrated to RMS.

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V.

Accuracy —

18°C to 28°C:

	25 Hz	45 Hz	10 kHz	20 kHz
200 mV to 200 V Ranges	±[1% of reading +0.1% of full scale (2 counts)]	±[0.5% of reading +0.1% of full scale (2 counts)]	±[1% of reading +0.1% of full scale (2 counts)]	
500 V Range	±[1% of reading +0.4% of full scale (2 counts)]			

0°C to 18°C and 28°C to 50°C:

	25 Hz	45 Hz	10 kHz	20 kHz
200 mV to 200 V Ranges	±[1.5% of reading +0.15% of full scale (3 counts)]	±[1% of reading +0.15% of full scale (3 counts)]	±[1.5% of reading +0.15% of full scale (3 counts)]	
500 V Range	±[1.5% of reading +0.6% of full scale (3 counts)]			

Common-Mode Rejection Ratio — ≥50 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 100 μV.

Response Time — ≤1.5 s.

Input Impedance — 10 MΩ paralleled by <130 pF.

Maximum Input Voltage — 500 V ac RMS or 600 V dc, not to exceed 1000 V peak.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, and 2000 kΩ.

Accuracy —

18°C to 28°C:	
200 Ω Range	±[0.5% of reading +0.1% of full scale (2 counts) +0.1 Ω]
2 kΩ to 2000 kΩ Ranges	±[0.5% of reading +0.05% of full scale (1 count) +0.1 Ω]
0°C to 18°C and 28°C to 50°C:	
200 Ω Range	±[0.9% of reading +0.15% of full scale (3 counts) +0.1 Ω]
2 kΩ to 200 kΩ Ranges	±[0.9% of reading +0.1% of full scale (2 counts) +0.1 Ω]
2000 kΩ Range	±[0.9% of reading +0.15% of full scale (3 counts) +0.1 Ω]

Response Time — ≤0.5 s.

Maximum Input Volts — 130 V dc continuous; 250 V ac for 30 minutes maximum.

HI-LO Ohms Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Resolution — 0.1 Ω.

Maximum Open Circuit Voltage Developed — Approximately 6 V.

AC AND DC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.

Accuracy —

Dc Current Only:

18°C to 28°C: ±[0.3% of reading +0.05% of full scale (1 count)]

0°C to 18°C and 28°C to 50°C — ±[0.4% of reading +0.1% of full scale (2 counts)]

Ac Current Only:

(from 45 Hz to 10 kHz)

18°C to 28°C — ±[0.7% of reading +0.1% of full scale (2 counts)]

0°C to 18°C and 28°C to 50°C — ±[1.25% of reading +0.1% of full scale (2 counts)]

Usable to 20 kHz.

Input Resistance —

Range	Approx. Resistance
200 μA	1001 Ω
2 mA	100.4 Ω
20 mA	10.25 Ω
200 mA	1.2 Ω
2000 mA	0.25 Ω

Response Time — ≤0.5 s for dc current, ≤1.5 s for ac current.

Maximum Open Circuit Voltage (mA to LO) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage (mA or LO to GROUND) — 1000 V peak.

Maximum Resolution — 0.1 μA.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except 1000 V dc and 500 V ac).

Measurement Rate — 3 per second.

Power Consumption — Approximately 8 watts.

Inputs — Maximum input voltage is 1000 V. The front panel volts/Ω, or LOW, or mA terminal can be floated 1000 V max. above ground, the rear input to 200 V peak. For the rear input, ac volts, ohms and maximum input specifications are derated.

Included Accessories — One pair test leads 003-0120-00.

For environmental specifications and accessories see page 187.

Order DM 505 Digital Multimeter $300

Digital Counters

Now TM 500 offers more counter capability than ever before with the addition of the versatile DC 509, DC 503A and DC 508A. These three new counters offer full-featured flexibility in the compact, configurable TM 500 package.

With the addition of the DC 509, DC 503A and DC 508A there is now a TM 500 Counter for virtually any application.

The DC 509 is designed for bench and lab applications where performance levels are critical. This 135 MHz counter is ideal for research and development work where flexibility and performance are desired. The DC 509 features auto-trigger, time interval averaging, and the powerful reciprocal counting technique to make high-resolution frequency and period measurements.

The DC 508A is a 1.3 GHz communications counter ideal for high frequency applications. The DC 508A, which features an audio frequency resolution multiplier, is particularly applicable to telecommunications, aerospace and two-way communications.

The DC 503A is a 125 MHz universal counter/timer designed for field service and general maintenance applications. The DC 503A is designed to offer a wide choice of performance features at an affordable price.

The DC 505A is a 225 MHz universal counter designed for research and development applications demanding high performance capabilities. The DC 505A is highly accurate with performance features like 10 ns clock rate and time interval averaging to 100 ps.

The DC 504 is an 80 MHz, general purpose counter available at an affordable price. The compact size of the DC 504 makes it particularly suitable for field service applications.

Tektronix offers maintenance training classes on the TM 500 Calibration Systems Package and a new multi-media training package on Digital Counter and Meter Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

DIGITAL COUNTERS—SELECTION GUIDE

	DC 503A	DC 504	DC 505A	DC 508A	DC 509
Number of digits	8	5	7	9	8
Frequency Range	125 MHz	80 MHz	225 MHz	1.3 GHz	135 MHz
Reciprocal Freq.	NO	NO	NO	NO	YES
Period	YES, plus Averaging	YES	YES, plus Averaging	NO	YES, plus Averaging
Width Averaging (single input)	YES	NO	YES	NO	YES
Time Interval Avg.	YES	NO	YES	NO	YES
Auto-Trigger	NO	NO	NO	NO	YES
Gated Events Avg.	A during B	NO	A during B	NO	B during A
Ratio Averaging	YES	NO	YES	NO	YES
Other	Option 01, trigger level & shaped outputs, time manual, totalize	Option 01, rpm	Option 01, trigger level & shaped outputs, totalize	Option 01, Option 07, resolution multiplier, 1 MΩ/50 Ω input	Option 01, trigger level & shaped outputs, self-test, phase modulated clock, probe compensation
Price	**$900**	**$575**	**$2,100**	**$1,400**	**$1,500**

DC 509

Universal Counter/Timer

NEW DC 509

- 135 MHz both A and B channels
- Eight measurement functions
  - Reciprocal Frequency (8 digits in less than 1 sec)
  - Period and Period Average
  - Width and Width Average
  - Time A→B and Time A→B Average
  - Events B during A Average
  - Totalize
  - Time Manual
  - Ratio B/A Average
- Duty Cycle Independent Auto-Trigger from 20 Hz to 135 MHz in Less Than a Second
- Trigger Level & Shaped Outputs for Ease of Triggering
- 10 ns Single-shot Resolution in all Timing Modes
- Designed for Serviceability including Power-up Self-test and Signature Analysis
- Auto or Selected Averaging from 1 to 10^8 in All Modes
- Probe Compensation Mode for True Probe Compatibility
- Arming for Added Measurement Capability with Complex Waveforms

The DC 509 Universal Counter/Timer makes frequency and period measurements to 135 MHz using the powerful reciprocal counting technique. This method provides high resolution of low frequency signals much faster than conventional counting techniques. Signals to be counted or timed can be applied to channels A or B via front panel BNC connectors or rear interface connections. The DC 509, designed to operate in a TM 500 Series Mainframe, offers a broad range of versatile features including Auto-Trigger, Auto-Averaging, and Probe Compensation.

Auto-Trigger, at the push of a button, senses the applied signal and sets both trigger

levels to the optimum trigger points. Channel A and B trigger levels can be monitored at front panel jacks or via rear interface connections. Available are buffered voltages corresponding to the trigger levels set by the front panel controls or the Auto-Trigger. Trigger level outputs are essential for accurate time interval measurements, especially when the rise and fall time of the signal accounts for a sizable portion of the time interval to be measured. The outputs of the signal shaping circuits can be monitored, also. These outputs are useful in setting the trigger points on complex waveforms.

The DC 509 provides eight measurement functions, and an averaging feature allows measurements to be averaged from 1 to 10^8 times with resolution to 1 picosecond. A pseudo-random, phase-modulated time base, standard in the DC 509, provides increased accuracy by eliminating clock-synchronous errors in the time interval and width averaging modes.

The DC 509, a microprocessor-based instrument, executes an extensive self-test routine when powered up. A unique feature—Probe Compensation—permits quick and accurate compensation of signal probes. An arming input allows measurements of selected events within complex waveforms.

The DC 509 can be equipped with an optional oven-controlled, 10 MHz crystal oscillator (Option 01) to obtain a more accurate, highly stable time base.

DC 509 SPECIFICATIONS

Display — Eight-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate. Overflow is indicated by a blinking display.

CHANNEL A AND B INPUT CHARACTERISTICS

Frequency Range — 0 to 135 MHz dc coupled. 10 Hz to 135 MHz ac coupled.

Sensitivity — 20 mV rms sinewave to 100 MHz, 40 mV rms sinewaves to 135 MHz, 115 mV p-p at min. pulse width of 3 ns.

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by ≈ 20 pF.

Dynamic Range — 3 V p-p x Attenuation.

Trigger Level — Adjustable ±3.2 V x Attenuation.

Auto-Trigger Frequency Range — 20 Hz to 100 MHz (V_{in} ≥125 mV p-p), typically 20 Hz to 135 MHz (V_{in} ≥200 mV p-p).

Independent Controls — Slope +/−, Atten. 1X/5X, Coupl. AC/DC, Source INT/EXT.

Max. Input Voltage —

1X 200 V pk; 400 V p-p from dc to 50 kHz, derate to 15 V p-p at 135.

5X 200 V pk; 400 V p-p from dc to 5 MHz, derate to 25 V p-p at 135.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms. Amplitude 0 to ≈ +0.4 V from 50 Ω.

Trigger Level Out — A dc level corresponding to the actual trigger level. Accuracy within ±10 mV of internal trigger level.

Arming Input — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

FREQUENCY A

Range — 100 μHz to 135 MHz.

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

Accuracy —

Resolution ± (Time Base Error) x Frequency A.

PERIOD A

Range — 7.40 ns to 3.05 hours.

Resolution — $\pm\text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N}$

Accuracy —

Resolution ± (Time Base Error) x Period A.

RATIO B/A

Range — 10^{-7} to 10^8

Resolution —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{B Trigger Jitter Error x Frequency B}}{N}$$

Accuracy — Same as Resolution.

TIME A→B

Range — 15 ns to 3.05 hours.

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times [\pm \text{Ch A Trigger Jitter Error} \pm \text{Ch B Trigger Jitter Error}]$$

Minimum Dead Time — 15 ns (stop to start).

Accuracy — Resolution ± (Time Base Error x Time A→B) + (Ch B Slew Rate Error − Ch A Slew Rate Error) ± Channel Delay Mismatch.

EVENTS B DURING A

Range — 10^{-7} to 10^8.

Maximum B Frequency — 135 MHz.

Minimum A Pulse Width — 15 ns (and 15 ns min. time between pulses).

Resolution —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} (\pm \text{Trigger Jitter Error Ch A start edge} \pm \text{Trigger Jitter Error Ch A stop edge}).$$

WIDTH A

Range — 15 ns to 3.05 hours.

Resolution —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} (\pm \text{Start Trigger Jitter Error} \pm \text{Stop Trigger Jitter Error}).$$

Accuracy — Resolution ± (Time Base Error x Width) + (Stop Slew Rate Error — Start Slew Rate Error) ±3 ns.

RESOLUTION AND ACCURACY DEFINITIONS

Trigger Jitter Error (seconds RMS) —

$$\frac{\sqrt{(e_{n1})^2 + (e_{n2})^2}\ (\text{V RMS})}{\text{Input Slew Rate at trigger point (V/s)}}$$

where e_{n1} = 120 μV RMS typical counter input noise

e_{n2} = RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.

Slew Rate Error (seconds) —

$$\frac{\text{Input Hysteresis/2}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Note: Input hysteresis is typically 20 mV p-p.

Channel Delay Mismatch — <2 ns between front panel inputs and <3 ns between rear interface inputs.

N = Number of Averages

The minimum number of averages is selected by the AVERAGES control in decade steps from 1 to 10^8. At Channel A repetition rates above approximately 10 Hz, the number of averages will be:

N = [Frequency A (Hz) x 0.1 seconds] + AVERAGES.

In the AUTO mode, the counter measures with a fixed measurement time of about 300 ms.

N (AUTO) ≃ Frequency A (Hz) x 0.3 seconds.

N is always ≥1.

Time Base Error — The sum of all errors specified for the time base used.

STANDARD TIME BASE

Crystal Frequency — 10 MHz.

Temp. Stability — ±5 x 10^{-6}, 0°C to 50°C.

Aging Rate — 1 x 10^{-6} per year.

Settability — Adjustable to within 5 x 10^{-8}.

HIGH STABILITY TIME BASE (OPTION 01)

Crystal Frequency — 10 MHz.

Temp. Stability — ±2 x 10^{-7} after warmup, 0°C to 50°C.

Warmup Time — Within 2 x 10^{-7} of final frequency in less than 10 minutes when cold-started at 25°C.

Aging Rate — 1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 1 x 10^{-6}/year after 60 days of continuous operation.

Settabiilty — Adjustable to within 2 x 10^{-8}.

REAR INTERFACE

Inputs — Channel A and B input to 50 MHz (50 Ω impedance, max. input 3.6 V pk); arming; reset; external time base (1, 5, or 10 MHz).

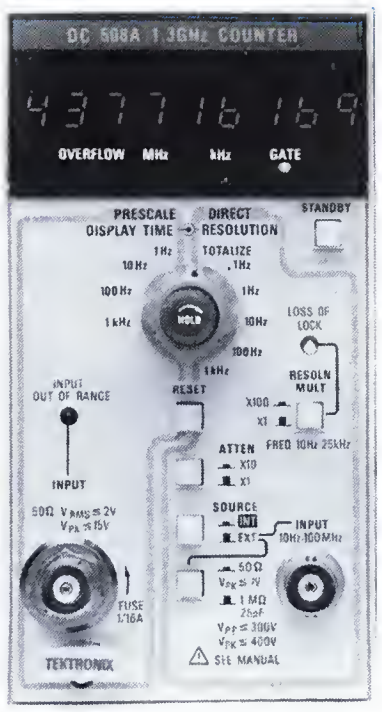
Outputs — Channel A and B shaped outputs; Channel A and B trigger level outputs; 10 MHz clock; gate out.

ORDERING INFORMATION

DC 509 . . . . . **$1500**

Option 01 High Stability Time Base . . . . . **Add $275**

Digital Counters



DC 508A

Frequency Counter

NEW DC 508A

- Frequency up to 1.3 GHz
- Sensitivity to 20 mV RMS Prescale, 15 mV RMS Direct.
- X100 Resolution Multiplier to 25 kHz
- Input Out-of-Range Light
- Nine Digit LED Readout
- Front Panel Fuse Protection on Prescale Input

The DC 508A Counter, designed to operate in a TM 500 Series Mainframe, measures frequency from 10 Hz to 1.3 GHz. A nine-digit LED display shows frequency or total events from 0 to 999,999,999. The prescaler input allows it to measure frequency from 100 MHz to 1.3 GHz, and the direct input from 10 Hz to 100 MHz. The decimal point is automatically positioned and leading zeros suppressed. Digit overflow is indicated by a front panel LED. Option 01 includes a high-stability time base, and Option 07 includes Option 01 and an interface for the TR 503 Tracking Generator/Spectrum Analyzer. An audio frequency resolution multiplier multiplies the resolution by 100 from 10 Hz to 25 kHz. This allows resolution of 0.01 Hz in 1 second. Detent position of Display Time knob provides a hold mode.

DISPLAY

Nine-digit LED display, leading zeros blanked, automatic decimal point positioning, LED front panel indicators for gate open, overflow, kHz, and MHz.

DIRECT INPUT

Frequency Range — 10 Hz to 100 MHz.

Sensitivity — 15 mV RMS.

Impedance — Selectable 50 Ω and 1 MΩ paralleled by 25 pF.

Maximum Operating Input Voltage — For 50 Ω is ≤7 V peak. For 1 MΩ 1X attenuation, V peak ≤400 V; V p-p ≤300 V from 10 Hz to 0.75 MHz, V p-p 225/f_{MHz} V from 0.75 MHz to 22 MHz, V p-p ≤10 V above 22 MHz; for a pulse, V peak ≤400 V and dV/dt ≤5 V/ns. For 1 MΩ, 10X attenuation, V peak ≤400 V; V p-p ≤300 V from 10 Hz to 1 MHz, V p-p ≤300/f_{MHz} V from 1 MHz to 6 MHz, V p-p ≤100 V above 6 MHz.

Attenuation — 1X, 10X.

Resolution (without resolution multiplier) — 0.1 Hz with 10 s gate, 1 Hz with 1 s gate, 10 Hz with 100 ms gate, 100 Hz with 10 ms gate, and 1 kHz with 1 ms gate.

Rear Interface Internal Input Sensitivity — 125 mV RMS to 50 MHz.

Rear Interface Internal Input Impedance — 50 Ω.

Rear Interface Internal Input Maximum Input Voltage — 4 V.

Resolution Multiplier Frequency Range — 10 Hz to 25 kHz.

Resolution Multiplier Multiplication — X100.

Resolution Multiplier Lock Time — ≤5 s.

PRESCALE INPUT (÷8)

Frequency Range — 100 MHz to 1.3 GHz.

Sensitivity — 20 mV RMS from ≤100 MHz to ≥1.1 GHz (−21 dBm) 40 mV RMS (−15 dBm) from 1.1 to 1.3 GHz.

Impedance — 50 Ω.

VSWR — ≤2.2:1.

Maximum Operating Input Voltage — V peak ≤15 V, V RMS ≤2 V (+19 dBm).

Resolution — 1 Hz with 8 s gate, 10 Hz with 800 ms gate, 100 Hz with 80 ms gate, and 1 kHz with 8 ms gate.

Input Protection Voltage — Input fuse opens at ≈9 V RMS (+30 dBm).

Input Out-of-Range LED — Indicates voltage or frequency too low for error-free counting.

TIME BASE

Frequency — 10 MHz; may also be used with external time bases with TTL levels at 1, 5, and 10 MHz.

Temperature Stability — 0°C to 50°C — ±5 x 10^{-6}.

Aging Rate — 1 X 10^{-6} per year.

OPTION 01 TIME BASE

Frequency — 10 MHz.

Temperature stability, 0°C to 50°C after warmup — Within 0.2 parts in 10^6 after warmup.

Warmup Time — Within ±0.2 ppm of final frequency in less than 10 minutes when cold-started at 25°C.

Aging Rate — ≤1 x 10^{-8}/day at time of shipping. ≤4 x 10^{-8}/week after a month of continuous operation. ≤1 x 10^{-6}/year after two months of continuous operation.

Setability — ±2 x 10^{-8}

Rear Inputs — Frequency, reset, external clock, start count.

Rear Outputs — BCD, decimal point, time slot zero, scan clock, data good, overflow, reset, gate out.

ACCURACY

The overall DC 508A accuracy is:

Accuracy (% of reading) = ± (time base accuracy + $\frac{1}{\text{total displayed counts}}$) x 100.

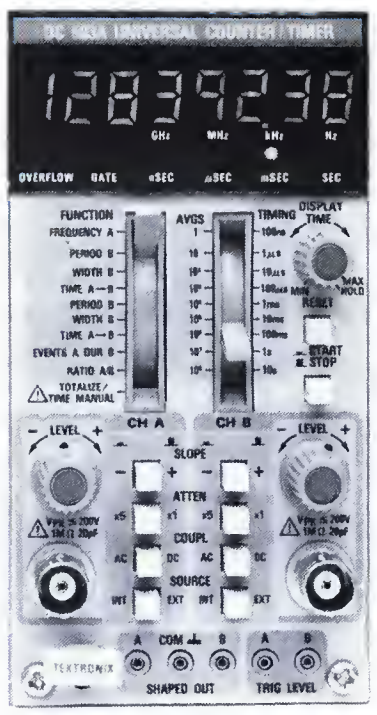
Time base accuracy ≤ ± [calibration accuracy + temperature stability + (aging rate x time since calibration) + short-term stability].

ORDERING INFORMATION

DC 508A Frequency Counter $1400

Option 01 (Time Base) ..... Add $275

Option 07 (Includes Option 01 Time Base) for use with TR 502 ..... Add $325



DC 503A

Universal Counter/Timer

NEW DC 503A

- 125 MHz both A and B channels
- Eight measurement functions
  - Frequency
  - Period and Period Average
  - Width and Width Average
  - Time A→B and Time A→B Average
  - Events A During B Average
  - Totalize
  - Time Manual
  - Ratio A/B Average
- 10 ps Resolution in Time Interval Average with 10^8 Averages
- Shaped Outputs for Ease of Triggering
- 40 MHz Rep Rate in Time Interval Average
- Simplified Width Measurement
- Designed for True Probe Compatibility
- Trigger Level Outputs for Accurate Trigger Setting

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125 MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A and an averaging feature allows measurements to be averaged from 1 to 10^8 times. Signals to be counted or timed can be applied to channels A and B via front panel BNC connectors, or through rear interface connections. The DC 503A features an easy access front panel and an LSI based design for increased instrument reliability.

The DC 503A can be equipped with an optional oven-controlled 10 MHz crystal oscillator (Option 01) to obtain a highly stable and precise internal time base. Both the optional oscillator and the standard 10 MHz

crystal oscillator provide 100 ns resolution of single-shot time intervals.

Channel A and B trigger levels can be monitored via front panel jacks. Available at these connectors is a buffered voltage which corresponds to the trigger levels set by the front panel controls. The trigger level outputs are essential to accurate time interval measurements, especially where the rise and fall time of the signal accounts for a sizable portion of the time interval to be measured. The output of the signal-shaping circuits can also be monitored via front panel connectors. These "shaped" signals are useful in setting triggering points on complex waveforms.

DC 503A SPECIFICATIONS

Display — Eight digit LED display, LED indicators for units, gate open, and overflow.
Display Time — Approximately 0.2 seconds to 5 seconds and hold.

CHANNEL A AND B INPUT CHARACTERISTICS

Frequency Range — 0 to 125 MHz, dc coupled. 10 Hz to 125 MHz, ac coupled.
Sensitivity — 20 mV RMS sine wave to 100 MHz, 35 mV RMS sine wave to 125 MHz. 60 mV p-p; at min pulse width of 5 ns to 100 MHz. 100 mV p-p at min pulse width of 4 ns to 125 MHz.
Impedance — 1 MΩ paralleled by ≈27 pF.
Attenuation — Selectable 1X, 5X.
Dynamic Range — $V_{in} \leq 3$ V p-p; x Attenuation.
Trigger Level — Adjustable ±3.5 V x Attenuation.
Independent Controls — Slope +/−, Atten. 1X/5X, Coupl. AC/DC, Source INT/EXT.
Max Input Voltage —
1X 200 V peak; 400 V p-p from dc to 5 kHz, derate to 15 V p-p from 1.33 MHz to 125 MHz.
5 x 200 V peak, 400 V p-p from dc to 5 MHz, derate to 20 V p-p from 100 MHz to 125 MHz.
Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms. ≥200 mV p-p from 50 Ω.
Trigger Level — A dc level corresponding to the actual trigger level. Accuracy ±20 mV ±0.5% of reading.

FREQUENCY A

Range — 0 to 125 MHz.
Resolution — 0.1 Hz to 10 MHz in decade steps.
Accuracy[a] = ±1 count ± time base error x Frequency A.

PERIOD B (SINGLE SHOT)

Range — 100 ns to 10^9 s.
Resolution — 100 ns to 10 s in decade steps.
Accuracy[a,c] = 1 count ± time base error x Period B ±1.4 x Ch B trigger jitter error.
Frequency Range — 0 to 125 MHz.

PERIOD B (Average)

Range — 8 ns to 10 s.
Resolution — 1 fs (10^{-15}) to 100 ns in decade steps.
Number of Averages — N = 1 to 10^8.

Accuracy[a,b,c] = $\pm\frac{100\text{ ns}}{N}$ ± time base error x Period B

$\pm\frac{1.4 \times \text{Ch B trigger jitter error}}{N}$

Frequency Range — 0 to 125 MHz.

WIDTH B (SINGLE SHOT)

Range — 100 ns to 10^9 s.
Resolution — 100 ns to 10 s in decade steps.
Accuracy[a,c,d] =
±1 count ± time base error x Width B.
±Ch B start trigger jitter error
±Ch B stop trigger jitter error
+ (Ch B stop slew rate error—Ch B start slew rate error).

WIDTH B (AVERAGE)

Range — 5 ns to 10 s.

Resolution — $\frac{100\text{ ns}}{\sqrt{N}}$

Number of Averages — N = 1 to 10^8 in decade steps.
Accuracy[a,b,c,d] =

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ± time base error x width B.

$\pm\frac{\text{Ch B start trigger jitter error}}{\sqrt{N}}$

$\pm\frac{\text{Ch B stop trigger jitter error}}{\sqrt{N}}$

+(Ch B stop slew rate error
−Ch B start slew rate error)
Frequency Range — 0 to 100 MHz.

TIME A→B (SINGLE SHOT)

Range — 100 ns to 10^9 s.
Resolution — 100 ns to 10 s in decade steps.
Accuracy[a,c,d] =
±1 count ± time base error x Time A→B
± Ch A trigger jitter error
± Ch B trigger jitter error
± (Ch B stop trigger slew error
−Ch A start trigger slew error)
±4 ns.

TIME A→B (AVERAGE)

Range — 12.5 ns to 10 s.

Resolution — $\frac{100\text{ ns}}{\sqrt{N}}$

Minimum Dead Time — 12.5 ns (Stop-to-Start).
Number of Averages — N = 1 to 10^8 in decade steps.
Accuracy[a,b,c,d] =

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ± time base error x Time A→B

$\pm\frac{\text{Ch A trigger jitter error}}{\sqrt{N}}$

$\pm\frac{\text{Ch B trigger jitter error}}{\sqrt{N}}$

+ (Ch B stop trigger slew error
−Ch A start trigger slew error)
±4 ns

EVENTS A DURING B (AVERAGE)

Max A Frequency — 125 MHz.
Min B Pulse Width — 5 ns.
Number of Averages — N = 1 to 10^8 in decade steps.
Accuracy[b,c,d] =

$\pm\frac{\text{Period A}}{\text{Width B} \times \sqrt{N}}$ x Events A during B

$\pm\frac{\text{Ch B start trigger jitter error}}{\sqrt{N}}$ x Frequency A

$\pm\frac{\text{Ch B stop trigger jitter error}}{\sqrt{N}}$ x Frequency A

+ (Ch B stop trigger slew error
− Ch B start trigger slew error) x Frequency A
(Note: Frequency in MHz)

RATIO A/B

Averaged over 1 to 10^8 cycles of channel B signal.
Frequency Range — 0 to 125 MHz (both Channels A & B).

Accuracy[b,c] = $\pm\frac{\text{Frequency B}}{\text{Frequency A} \times N}$

$\pm\frac{1.4 \times \text{Ch B trigger jitter error} \times \text{Frequency A}}{N}$

$\pm\frac{\text{Frequency A}}{0.3 \times 10^8}$

TOTALIZE A

1 to 99,999,99 counts at max rate of 125 MHz. Start, stop and reset controlled by front panel pushbuttons or rear interface signal lines.

TIME MANUAL

Electronic stopwatch, accumulates and displays time between activation of front panel start/stop button or rear interface signal line. Clock rates selectable from 100 ns to 10 s in decade steps. Range 100 ns to 10^9 s.

STANDARD TIME BASE

Crystal Frequency — 10 MHz.
Temp Stability — < ±5 x 10^{-6}, 0°C to 50°C.
Aging Rate — <1 x 10^{-6} per year.
Settability — Adjustable to within 5 x 10^{-8}.

OPTION 01 HIGH STABILITY TIME BASE

Crystal Frequency — 10 MHz.
Temp Stability — < ±2 x 10^{-7} after warm-up, 0°C to 50°C.
Warmup Time — Within 2 x 10^{-7} of final frequency in less than 10 minutes when cold started at 25°C.
Aging Rate — 1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 1 x 10^{-6}/year after 60 days of continuous operation.
Settability — Adjustable to within 2 x 10^{-8}.

REAR INTERFACE

Inputs — Direct count input to 50 MHz, (50 Ω impedance, resistor may be removed for 1 MΩ input); remote start/stop, reset; external time base.
Outputs — BCD serial-by-digit, decimal point, overflow, scan clock; trigger level; time base reference.

NOTES:

A) Time base error is the sum of all errors specified for the time base used.

B) N is the number of periods averaged in PERIOD B (AVGS) mode, the number of intervals averaged in the TIME A→B (AVGS) mode, the number of widths of B averaged in WIDTH B (AVGS) and EVENTS A DURING B modes, and the number of periods of B in the RATIO A/B mode.

C) Trigger jitter error = (in μs)

$$\frac{\sqrt{(en_1)^2 + (en_2)^2\,(V)}}{\text{Input slew rate at trigger point (V/}\mu\text{s)}}$$

Where en_1 = 100 μV RMS typical internal noise.
en_2 = RMS noise of the signal input at the trigger point for a 125 MHz bandwidth.

D) Trigger slew rate error = (in μs)

$$\frac{\frac{\text{Input hysterisis (V)}}{2}}{\text{Input slew rate at set trigger point (V/}\mu\text{s)}}$$

Where input hysterisis = 20 mV p-p typical.

ORDERING INFORMATION

DC 503A **$900**
Option 01 High Stability Time Base . . . . . **Add $275**

NEW P6125 COUNTER PROBE 5X

The P6125 is a new low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

SPECIFICATIONS

Attenuation — 5X.
Input Resistance — 5 MΩ Input.
Capacitance — Approx. 20 pF.
Bandwidth — Dc to 200 MHz.
Voltage Rating — 250 V (dc + peak ac) derated to 35 V at 100 MHz.
Cable Length — 1.5 meters.

INCLUDED ACCESSORIES

352-0351-00		1 HOLDER, probe
013-0107-03		1 TIP, retractable hook
	*	1 TIP, IC tester
	**	2 TIPS, probe
344-0046-00		2 CLIPS, miniature, alligator
175-0124-01		1 LEAD, ground, 13 cm
175-0263-01		1 LEAD, ground, 8 cm
166-0404-01		1 SLEEVE, insulating
016-0521-00		1 POUCH, accessory

*Available in packages of 10 (015-0201-01) or 100 (015-0201-02) only.
**Available in packages of 10 only (206-0191-01).

P6125 Counter Probe, 5X, 1.5 m,
Order 010-6125-01 . . . . . **$50**

Digital Counters

DC 505A Universal Counter/Timer

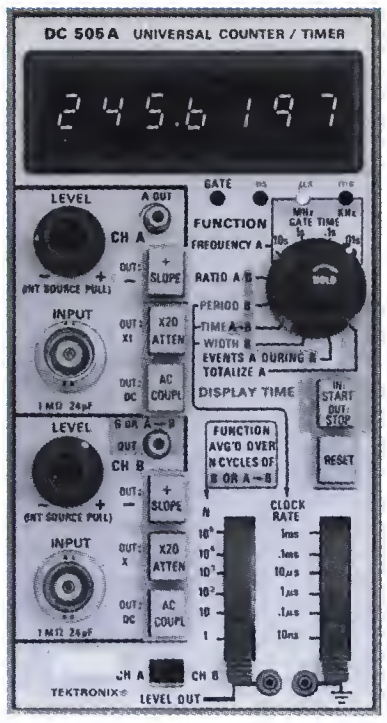
Dc Output for Accurate Trigger Level Setting with Companion DMM

Direct Counting to 225 MHz 10 ns Clock Rate

Two Equal Bandwidth Channels for Time Measurements on Narrow Pulses

Time Interval Averaging with Resolution to 100 ps

Events A During B



The DC 505A is a high-performance universal counter featuring direct counting to 225 MHz. Both channels A and B have equal response for ratio, time interval, and other measurements requiring two channels. The DC 505A provides dc trigger level output both at the front-panel jack and rear interface connector. Any TM 500 Digital Multimeter may be connected via the rear interface to read the DC 505A trigger level setting.

Various functions include conventional frequency operation on channel A, ratio of channel A to B frequency, period of signal B, time interval from channel A start to B stop, width B, events A during B, and totalize. An averaging feature allows measurements to be averaged from 1 to 10^5 times as selected by front-panel controls with the resultant average displayed on the LED readout. Averaging factor and clock rate are independently selectable. Pulse width may be measured directly with single shot resolution to 10 ns. By use of maximum averaging on width or interval measurements of repetitive waveforms, resolution to better than 100 picoseconds is possible. Typical application of the DC 505A is in the design, development, or maintenance of logic circuitry in high speed digital computers.

Display — 7 digit LED display.
Frequency (A input) — Range: 0-225 MHz, dc coupled. 10 Hz to 225 MHz, ac coupled. Gate Times: 0.01 s, 0.1 s, 1 s, 10 s.
Frequency Accuracy — ±1 count ± time-base error.
Time Interval Resolution — Single event: 10 ns to 1 ms selectable. Repetitive Events: ≤100 ps with 10 ns clock and 10^5 averaging. Clock rate selectable, 10 ns to 1 ms. Averaging factor independently selectable from 1 to 10^5. 5 ns minimum pulse width in either channel.
Time Interval Accuracy — ±1 count ± time base error ± trigger error CH A* ± trigger error CH B* ± channel delay match error (2 ns max) ± slew rate error*** +2 counts (10 ns clock rate only). Best absolute accuracy 3 ns.
Width (B Input) — Single pulse: 10 ns to 1 ms, selectable. Repetitive pulses: ≤100 ps with 10 ns clock and 10^5 averaging factor. Clock rate selectable 10 ns to 1 ms. Averaging factor independently selectable in decades from 1 to 10^5. 2 ns minimum pulse width.
Width Accuracy — ±1 count ± time base error + hysteresis error** ± slew rate error*** + 2 counts (10 ns clock rate only). Best absolute accuracy, 1.5 ns.
Period & Period Averaging (B input) — Resolution: 10 ns to 1 ms for single period; 0.1 ps max with 10 ns clock and 10^5 averaging. Accuracy: ±1 count ± time-base error ± trigger error† +2 counts (10 ns clock rate only).
Ratio (A/B) — Averaged over 1 to 10^5 cycles of signal at B. Accuracy: ±1 count FREQ A ± trigger jitter Ch B†.
Events A during B — Averaged over 1 to 10^5 occurrences of signal at B. Accuracy: ±1 count FREQ A + hysteresis error** ± slew rate error***.
Totalize (A) — 1 to 9,999,999 at max rate of 225 MHz. Front panel start, stop, reset control.
Input Frequency Range (A and B) — 0 to 225 MHz, dc coupled. 10 Hz to 225 MHz, ac coupled.
Sensitivity, A and B — 150 mV p-p (50 mV RMS sine wave) below 150 MHz. 300 mV p-p (100 mV RMS sine wave) from 150 to 225 MHz.
Impedance (A and B) — 1 MΩ paralled by 24 pF.
Trigger Level (A and B) — Adjustable ±2.0 V at 1X attenuation.
Max Input Voltage (A and B) — 1X Atten: 50 V at 10 kHz or less; derate −20 dB/decade to 100 kHz. 5 V from 100 kHz to 225 MHz. 20X Atten: 250 V at 1 MHz or less, derate −20 dB/decade to 50 MHz. 5 V from 50 MHz to 225 MHz.
Attenuation (A and B) — Selectable 1X, 20X.
Standard Time Base — Temp stability, 0°C to 50°C after warm-up: ±1 X 10^{-5} (0.001%). Long Term Drift: ±1 X 10^{-5} per month (0.001%). Setability: Adjustable within 1 part in 10^{-7} (0.00001%).
Option 01 Time Base Accuracy — Temp Stability, 0°C to 50°C after warm-up: ±5 X 10^{-7} (0.00005%). Long Term Drift: ±1 X 10^{-7} (0.00001%). Setability: Adjustable within 5 parts in 10^9 (0.0000005%).
Rear Interface Input — Reset, external display scan clock, external time base Ch A, Ch B.
Rear Interface Output — Bcd serial-by-digit plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

NOTES:

$$* = \left(\frac{0.01\ V}{dv/dt\ of\ triggering\ edge}\right) / \sqrt{N}$$

$$** = \left(\frac{0.1\ V}{dv/dt\ of\ stop\ edge}\right) \pm \left(\frac{0.1\ V}{dv/dt\ of\ start\ edge}\right) \pm \left(\frac{0.01\ V}{dv/dt\ of\ triggering\ edge}\right) / \sqrt{N}$$

*** Input amplifier slew rate of 10 ns/volt will produce additional error in
(1) Time A → B mode if A and B level controls are not set for corresponding points on waveforms.
(2) Width B and Events A during B modes if B level control is not set at 50% of input pulse height.

$$† = \left(\frac{0.01\ V}{dv/dt\ triggering\ edge}\right) / N$$

NOTE 1: Accuracies with averaging are dependent on the laws of statistics in Time A → B, Width B, and Events A during B modes.

Special Features — A out: Shaped output, after LEVEL and SLOPE selection, of signal into Ch A. This output represents what goes into the display of FREQ A, RATIO A/B and TOTALIZE A. Propagation delay from Ch A INPUT to A OUT is ≈15 ns.
B or A→B OUT — Shaped output, after LEVEL and SLOPE selection, of either Ch B signal or A→B signal. This output represents the continuous signal used in generating the display gating for RATIO A/B, PERIOD B, TIME A→B, WIDTH B, AND EVENTS A DURING B. Propagation delays from the channel INPUTS TO B or A→B OUT are ≈15 ns.
Included Accessories — 1 cable assembly, rf, 3.5 ft. (012-0532-00)

ORDERING INFORMATION

DC 505A **$2100**
Option 01 (Time Base) ..... **Add $200**

DC 504 Counter/Timer

Direct Frequency Counting to 80 MHz

Period Measurement for Resolution at Low Frequency

Rpm Counting

5 Digit LED Display

Low Cost

The DC 504 Counter/Timer measures frequency from 0 Hz (with 0.1 Hz resolution) to 80 MHz, period from 1 microsecond to 999.99 seconds, and totalizes events from 0 to 99,999 at a maximum rate of at least 80 MHz. A resolution of 0.1 Hz can be obtained by allowing the more significant figures of the counter to overflow. Five 7-segment light-emitting diodes (LEDS) provide a visual numerical display. The decimal point is automatically positioned and leading zeros are blanked. Digit overflow is indicated by a front-panel LED. Signals to be counted/timed can be applied to either a front-panel BNC connector or to the rear interface connector. Internal switches select frequency or rpm operation, internal time base or external standard, and override display storage.

Display — 5 digits LED display.
Accuracy — ±1 count ± time-base accuracy (±trigger error in period mode only).
Frequency (or rpm) — Dc coupled: 0 Hz to at least 80 MHz. Ac coupled: 10 Hz to at least 80 MHz.
Frequency/rpm (Max Resolution) — kHz Positions: 0.1 Hz, 1 Hz, and 10 Hz (1 rpm, 10 rpm, and 100 rpm).* MHz Positions: 0.1 kHz and 1 kHz (1000 rpm and 10 k rpm).*
Sensitivity — 20 mV RMS (56.6 mV p-p) below 15 MHz, 35 mV RMS (99 mV p-p) at or below 50 MHz derating to typically <175 mV RMS (495 mV p-p) at 80 MHz.
Triggering Level — Adjustable from at least −1.5 V to +1.5 V.
Trigger Source — Internal (rear connector interface) or external (front-panel BNC).
Max Input Voltage — (sinewave, dc + peak ac) ±250 V at 500 kHz or less; derate −20 dB/decade to 25 MHz. ±5 V from 25 MHz to 80 MHz.
Impedance — 1 MΩ paralleled by approx 20 pF.
Coupling — Dc or ac.
Internal Time Base —

	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz temperature compensated
Stability (0°C to 50°C) after ½ hour warm-up	≤±1 x 10^{-5}	≤±5 x 10^{-7}
Long-term Drift	≤±1 x 10^{-5} per month	≤±1 x 10^{-7} per month
Setability	Adjustable to ±1 x 10^{-7}	Adjustable to ±5 x 10^{-9}

Totalize Events (Resolution) — 1 count.
Period (Resolution) — mSec Position: 1 μs and 10 μs Sec Position: 0.1 ms, and 10 ms.
Display Time — Variable from about 0.1 s to about 10 s. Detent position at cw position of DISPLAY TIME knob provides a HOLD mode.
Data Inputs and Outputs — Available at rear of plug-in for intra-compartment routing in any TM 500 Power Module/Mainframe. Bcd serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

ORDERING INFORMATION

DC 504 Counter/Timer **$575**
Option 01 (Time Base) ..... **Add $200**

*This assumes that the transducer output is one pulse per revolution.

Power Supplies

CHARACTERISTICS COMMON TO PS 501-1, PS 503A

20 V FLOATING SUPPLY

Primary Power Input — Determined by mainframe (TM 501, TM 503, etc).

Output — Floating, isolated for 350 V dc + peak ac above ground.

Stability — Typically (0.1% +5 mV) or less drift in 8 hours at constant line, load, and temperature.

Indicator Lights — Voltage variation and current limit.

+5 V GROUND-REFERENCED SUPPLY

Output — 5 V nominal, ±0.25 V at 1 A.

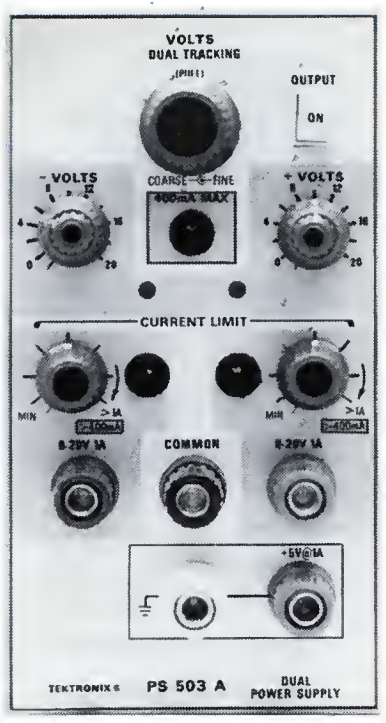
Load Regulation — Within 100 mV with a 1 A load change.

Line Regulation — Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A) — 5 mV p-p or less, 20 Hz to 5 MHz.

Stability — Typically 30 mV or less drift in 8 hours.

Overload Protection — Automatic current limiting and over-temperature shutdown.



PS 503A

Triple Power Supply

PS 503A

- Independent + and − Controls
- Dual Tracking Voltage Control
- 0 to ±20 V at 1 A (in high-power compartment)
- Fixed Output + 5 V @ 1 A
- Remote Resistance Programming
- Over-Voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 Mainframe, the PS 503A provides up to 1 amp from both 0 to 20 volt supplies.

±20 V FLOATING SUPPLIES

Outputs — 0 to ±20 V dc with respect to the common terminal or 0 to 40 V dc across the + and − terminals. Outputs can be varied independently or at a constant ratio.

Maximum Rated Current — 400 mA (1 A in high power compartment to +30°C derating to 300 mA (750 mA) at +50°C.

Tracking Mode Offset Error — If the two supplies are set independently to any given voltage ratio and then varied by use of the VOLTS DUAL TRACKING control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

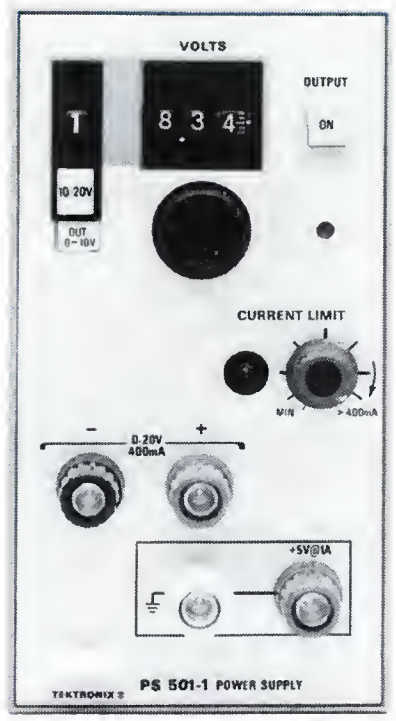
Current Limit — Adjustable from less than 100 mA to 1 A (high-power compartment) or less than 40 mA to 400 mA (standard compartment) on each supply.

Load Regulation — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

Ripple and Noise — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

Indicators — Individual voltage indicators and current limiting indicators for both + and − supplies. Standard compartment (400 mA) indicator.

Order PS 503A Power Supply $500



PS 501-1

Power Supply

PS 501-1

- Floating Output, 0-20 V
- 0 to 400 mA
- Precise Regulation
- Low Ripple and Noise
- Fixed Output + 5 V @ 1A
- 3½ Digit Ten Turn Dial

The PS 501-1 features precise regulation and better than 2 mV resolution (settability) over a 0 to 20 V range.

Output — 0 to 20 V dc.

Maximum Rated Current — 400 mA to +30°C derating to 300 mA at +50°C.

Accuracy — ±(0.5% + 10 mV).

Current Limit — <40 to 400 mA.

Line Regulation — Within 5 mV for a ±10% line voltage change.

Load Regulation — Within 1 mV for a 400 mA load change.

Ripple and Noise — 0.5 mV p-p or less; 0.1 mV RMS or less, 20 Hz to 5 MHz.

Temperature Coefficient — Typically less than (0.01% +0.1 mV) per °C.

Minimum Resolution — Typically 1.6 mV.

Transient Recovery Time — 20 μs or less to recover within 20 mV of final output voltage after a 400 mA change in output current.

Order PS 501-1 Power Supply $400

Pulse Generators

The TM 500 Pulse Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The newest addition to the TM 500 Pulse Generator family, the PG 507, features complementary dual outputs making it ideally suited for digital applications. The dual output feature is particularly useful when working with ECL logic families.

Similar to the PG 507 Pulse Generator is the 50 MHz PG 508 featuring independently variable rise and fall times. The PG 508's high level performance and versatility cover a broad range of test and measurement applications.

The PG 507 or PG 508's accurate 50 Ω output impedances deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50 MHz multipurpose generators are also designed for high level performance on high impedance circuits (MOS, HTL, and CMOS logic).

In 50 Ω systems, our PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families, (TTL, DTL and ECL), in repetition rates, amplitudes and transition times.

Our PG 505 100 kHz Pulse Generator features custom timing positions to allow addition of internal capacitors to custom-select or extend pulse period and duration.

Our TM 500 Pulse Generators' wide range of features afford you ease of operation, even on the most challenging test and measurement problems.

PULSE GENERATORS —

	NEW PG 507	PG 508
Pulse Period	≤20 ns to ≥200 ms (50 MHz to 5 Hz)	
Pulse Duration Duty Factor	≤10 ns to ≥100 ms	
	≥70% to 0.2 μs period, ≥50% at 20 ns period	
Square Wave Mode	YES	YES
Pulse Delay Duty Factor	≤10 ns to ≥100 ms[1]	≤10 ns to ≥100 ms[1]
	≥70% to 0.2 μs period, ≥50% at 20 ns period	
Double Pulse	YES	YES
Transition Times	Fixed, ≤3.5 ns, ≤4 ns @ >5 V	≤5 ns to ≥50 ms, Independently variable up to 100:1
Aberrations	≤5% p-p +25 mV into 50 Ω load	≤5% p-p +50 mV for pulse within ±5 V into 50 Ω load
Amplitude: Into 50 Ω	≥7.5 V p-p, ±7.5 V window	≥10 V p-p, ±10 V window
Open Ckt	≥15 V p-p, ±15 V window	≥20 V p-p, ±20 V window
Source Impedance	50 Ω	50 Ω
Simultaneous Outputs	YES, complementary	NO
Pulse Coincidence	≤1 ns at 50% amplitude	NA
Output Controls	Independent pulse top and pulse bottom, normal or PRESET	
Normal/Complement	YES, both outputs	YES
Positive/Negative	NO	NO
Remote Amplitude	Rear interface inputs	Rear interface inputs
Locked On Mode	NO	NO
Back Termination	Always back terminated	Always back terminated
External Input	1 MΩ or 50 Ω input impedance	1 MΩ or 50 Ω input impedance
Trigger Level	−3 V to +3 V, 80 mV p-p sensitivity to 10 MHz 250 mV p-p to 50 MHz, TRIG'D/GATED light	
Slope	+ or −	+ or −
Trigger Mode	YES	YES
Manual Trigger	YES	YES
Duration Mode	YES	YES
Gate Mode	YES	YES
Counted Burst	YES, with DD 501[3]	YES, with DD 501[3]
Trigger Output (50% squarewave or follows external signal[2])	≥+2 V from 50 Ω, approx. 35 ns prior to pulse output (23 ns in square wave or EXT DUR modes)	
Custom Timing Positions	User installed capacitors	User installed capacitors
Control Error Light	YES	YES
Temperature	0°C to +50°C Operating, −55°C to +75°C Non-operating	

(1) Add 60 ns for delay from external trigger.

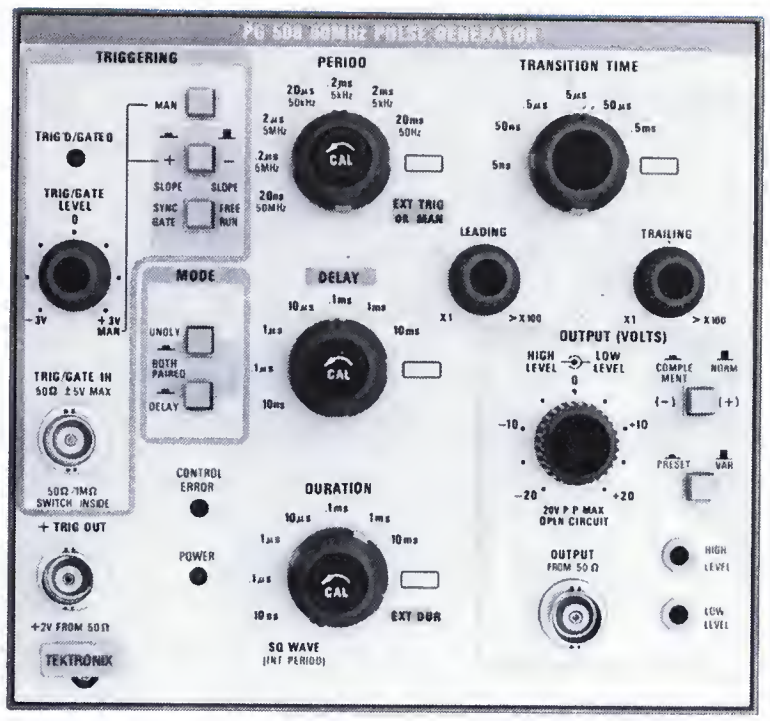
(2) PG 505 trigger output follows pulse output.

(3) Exact count to 20 MHz, usable to 50 MHz.

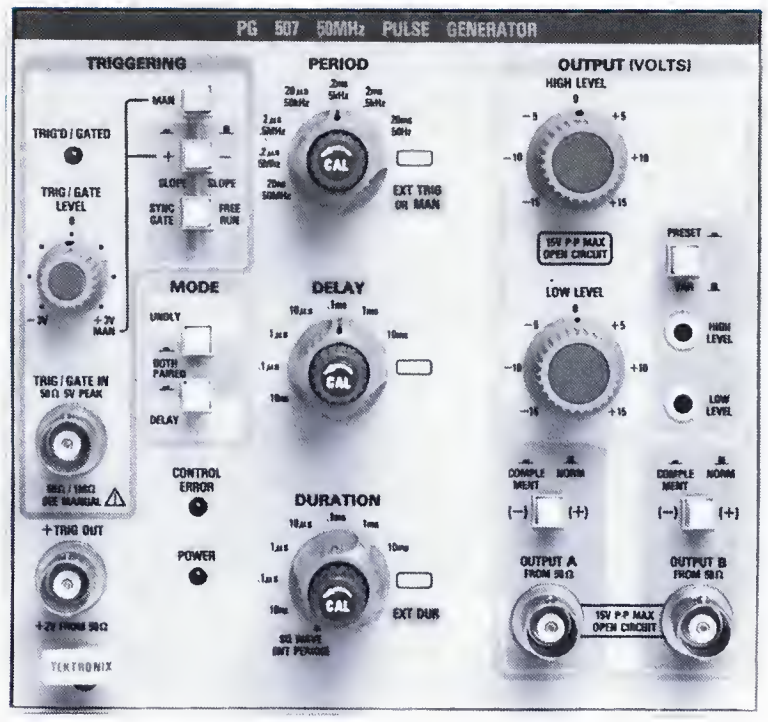
COMPARISON OF CHARACTERISTICS

PG 501	PG 502	PG 505
≤20 ns to ≥200 ms (50 MHz to 5 Hz)	≤4 ns to ≥100 ms (250 MHz to 10 Hz)	≤10 μs to ≥1 s (100 kHz to 1 Hz)
≤10 ns to ≥100 ms	≤2 ns to ≥50 ms	≤5 μs to ≥0.5 s
≥70% to 0.2 μs period, ≥50% at 20 ns period	≥50%	approaches 100%
NO	YES	NO
Fixed, 20 ns from external trigger	Fixed, 17 ns from external trigger	Anywhere along +10 V external ramp
NO	NO	NO
Fixed, ≤3.5 ns	Fixed, ≤1.0 ns	≤1 μs to ≥20 ms. Independently variable up to 20:1
Within 3.5% at 5 V into 50 Ω load	Within 5% at 5 V p-p (durations ≥5 ns)	Within 5% at max output into 4 kΩ, 20 pF load
≥5 V	5 V, ±5 V window	typ +1 V or −1 V
not specified	5 V, ±5 V window	≥+80 V or ≥−80 V
not specified	1 kΩ or 50 Ω	4 kΩ
YES, positive and negative	NO	NO
≤1 ns at 50% amplitude	NA	NA
Independent amplitude controls for + and − outputs, no offset	Independent pulse top and pulse bottom	Amplitude control, no offset
NO	YES	NO
NO	NO	YES
NO	NO	NO
YES	NO	YES
NO	YES, switchable	NO
50 Ω input Z	50 Ω input Z	10 kΩ input Z
+1 V required	+1 V required	+0.5 V to +10 V
+ Only	+ Only	+ Only
YES	YES	YES
NO	YES	NO
YES	YES	YES
NO	NO	NO
NO	NO	NO
≥+2 V from 50 Ω, approx. 8 ns prior to pulse output	≥+2 V from 50 Ω, approx. 10 ns prior to pulse output	≥+4 V from 200 Ω
NO	NO	User installed capacitors
NO	NO	NO
0°C to +50°C Operating, −55°C to +75°C Non-operating		

Pulse Generators



PG 508



PG 507

50 MHz Pulse Generator

PG 507/PG 508
Common Characteristics

- 5 Hz to 50 MHz Plus Custom Range
- Delay and Double Pulse Capability
- Independent Pulse Top and Bottom Level Controls
- True 50 Ω Output Impedance for Clean Waveforms
- Control Error Light Warns of Improperly Set Switch or Variable Controls
- 3 State Trigger Light Indicates Proper External Triggering
- Selectable 1 MΩ/50 Ω Trigger Input Impedance for Optimum Match to Circuitry —Lets You Use Your Scope Probe

The PG 507 and PG 508 combine TM 500 configurability with state-of-the-art capabilities. Their high-level performance and unique versatility cover a broad range of test and measurement applications and logic design functions in MOS, CMOS, TTL and ECL.

With an output of up to 15 V p-p for the PG 507 and 20 V p-p for the PG 508, both instruments also feature independent controls for output period, delay and duration times. Other features include selectable 1 MΩ/50 Ω trigger input impedance, a control error light, a 3 state trigger/gate light, and preset or external control of output voltage levels.

Simply pushing the preset button can change the output from variable top and bottom controls to front panel screwdriver adjustments, or track external supply voltages.

The complement mode of either generator allows an output duty cycle range approaching 100% to be conveniently set-up with more accuracy, range and stability.

You can gate the PG 507 or PG 508 with a positive- or negative-going signal, or by pressing the MAN button. Or dial up a predetermined number of pulses in a burst by adding the DD 501's independent digital delay capabilities for Counted Burst mode; especially useful for testing circuits at different frequencies with the same number of pulses.

And there's more; with the trigger input switched to 1 MΩ impedance, you can explore circuitry using a 1X or 10X scope probe. The PG 507 or PG 508 can be used as a pulse regenerator, logic level translator, or sine wave to pulse converter.

The PG 507's and PG 508's output is capable of driving MOS, CMOS, DTL, HTL I^2L, T^2L or ECL.

50 MHz Dual Output Pulse Generator

NEW PG 507

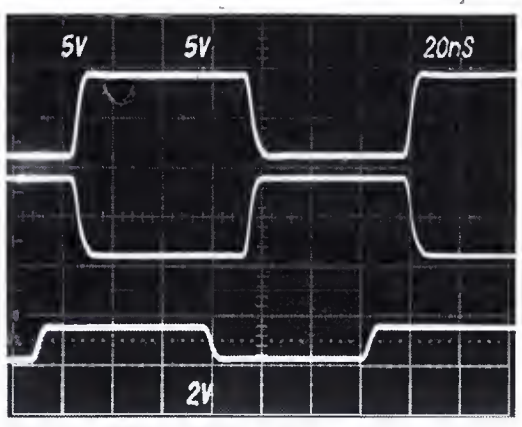
- Dual Outputs with Tracking Level Controls
- Normal or Complement Pulse Output on Both Channels
- 15 V Output in a ±15 V Window into Hi Impedance, 7.5 V into 50 Ω
- 3.5 ns Rise/Fall Time

The PG 507 is a high performance, 50 MHz pulse generator designed specifically for logic design applications.

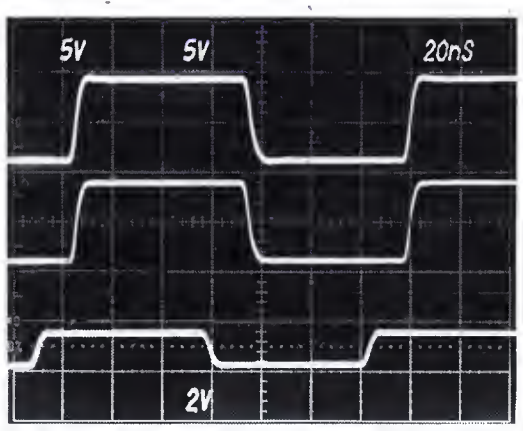
The PG 507 features complementary dual outputs which greatly increase its applicability in logic design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

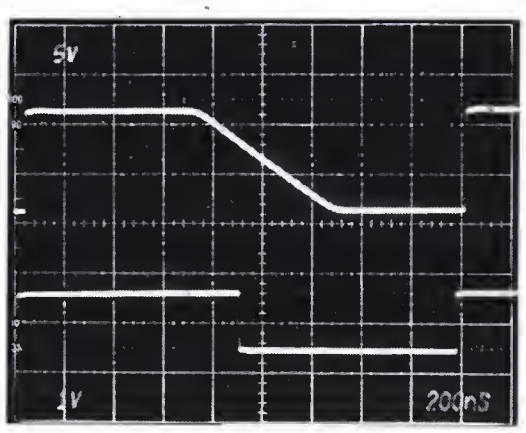
The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and si-



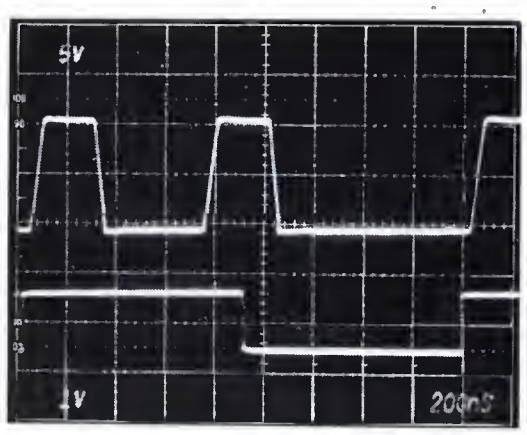
PG 507 trigger output and outputs switched to complementary mode.



PG 507 trigger output and outputs switched to positive going mode.



PG 508 output with fall times set 100 times longer than rise time.



PG 508 output in paired pulse mode with rise and fall times set equally.

multaneous positive mode (Channel A output positive going, Channel B output positive going).

In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic design or control applications requiring simultaneous signals.

ORDERING INFORMATION

PG 507 50 MHz Pulse Generator $1650

DD 501 Digital Delay (page 217) **$1075**

P6062B and P6108 Probes are recommended.

PG 508

Independently Variable Rise and Fall Times to 5 ns

20 V Output in a ±20 V Window to Hi Impedance, 10 V into 50 Ω

Normal or Complement Output

The PG 508 50 MHz Pulse Generator is a highly versatile, general purpose pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real world waveforms. This capability is particularly useful in research and development applications demanding versatility in rise and fall times like testing of amplifiers, slew rate testing, comparator simulation and logic circuitry performance tests.

For example, controllable rise and fall times are extremely desirable when working with CMOS where logic power consumption increases with slower rise times. Also, variable rise and fall times are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the rise and fall times controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different rise and fall times, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508, is the capability of changing output amplitude while variable rise and fall times remain constant.

ORDERING INFORMATION

PG 508 50 MHz Pulse Generator $1650

PG 508T 50 MHz Pulse Generator $1920
(includes PG 508, TM 503 Mainframe, and 016-0195-03 blank panel)

For Counted Burst, order the
DD 501 Digital Delay (page 217) **$1075**

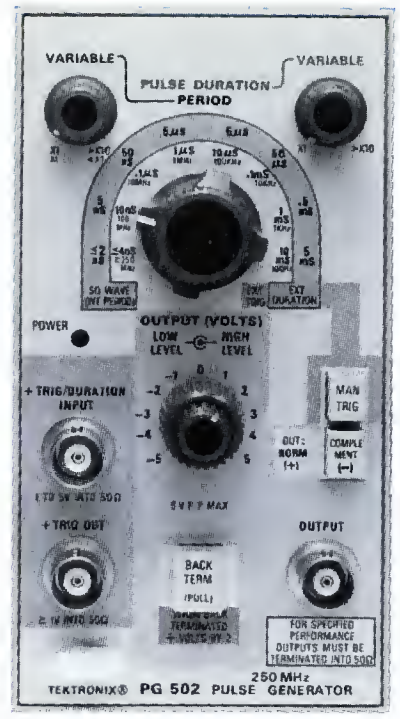
Suggested 10 in BNC 50 Ω cable (2 req) for interconnecting PG 508 and DD 501:
012-0208-00 . . . . . **$14**

P6062B and P6108 Probes are recommended.

PG 501

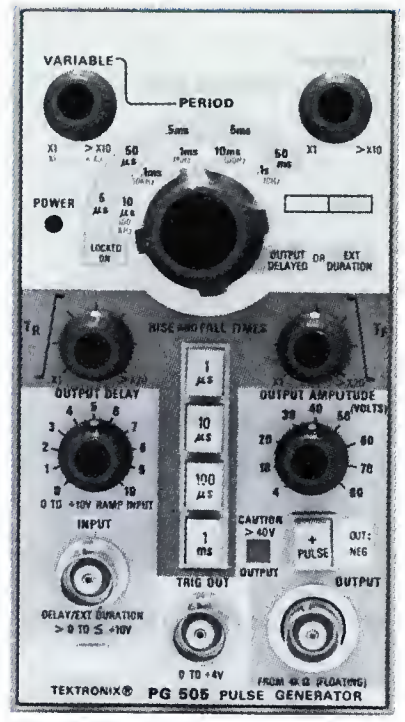
50 MHz Pulse Generator

PG 502



250 MHz Pulse Generator

PG 505



100 kHz Pulse Generator

PG 501

5 Hz to 50 MHz

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns into 50 Ω

Independent Period and Duration Controls

Trigger Out

The PG 501 is a 50 MHz Pulse Generator featuring simultaneous plus and minus outputs; a wide range of pulse period durations, and duty factors; trigger output and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

Order PG 501 50 MHz Pulse Generator $600

PG 502

10 Hz to 250 MHz

1 ns Rise Time

5 V Output ±5 V Window

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Manual Trigger Button

The PG 502 (250 MHz Pulse Generator) features: fast rise and fall times; independent top and bottom pulse levels; and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

Order PG 502
250 MHz Pulse Generator $2100

PG 505

1 Hz to 100 kHz

Independently Variable Duration and Period

80 V Output

Variable Rise Time and Fall Time

Delay Mode

The PG 505 Pulse Generator features: floating output; independently adjustable rise and fall times; external control of period or period and duration. A special position on the pulse period and pulse duration controls allows addition of an internal capacitor to custom-select pulse period and duration. When driven from an externally supplied 0 to 10 volt ramp, the delay control of the PG 505 permits the output pulse to occur at any selected voltage point on the ramp, thus providing controllable time delay to any set time along the ramp.

Order PG 505 100 kHz Pulse Generator $775

MANUAL (ONE-SHOT) TRIGGER GENERATOR

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501, PG 505, and RG 501.

Order 016-0597-00 . . . . . $125

Function Generators

Our TM 500 Function Generators offer versatility at an affordable price.

Use the triangular waveform capability of each TM 500 Function Generator with your oscilloscope to examine crossover distortion, determine the overload (clipping) point, or the overload recovery characteristics of amplifiers. Or use the square waveforms to simultaneously reveal low frequency response (by sag), high frequency response (by rise time), and transient response (by ringing and other aberrations) of amplifiers.

For electronic applications, sine waves display the full frequency response of a number of devices. Pulse and square waves can be used as clock and signal sources in logic circuitry-based applications.

For applications demanding logarithmic or linear sweep the new FG 507 offers a accurate and versatile solution. The low distortion of the FG 507 (0.25%), combined with log and lin sweep is particularly useful in audio and communications-oriented applications.

For low-frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical and mechanical simulations or on servo systems.

Applying an external ramp to the vcf (Voltage Controlled Frequency) input, allows our functions generators to double as sweep generators. The vcf input fed from a low-level modulating signal can produce a frequency-modulated carrier. The FG 507 and FG 504 have sweep capabilities conveniently built in that simplify setting up start and stop frequencies in addition to providing logarithmic sweep.

Sweeping wide frequency ranges (100:1 or greater), with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform with the FG 501A, FG 504, and FG 507 in the gated (burst) or triggered mode. A gated or triggered waveform efficiently tests tone-controlled systems, loud speaker transient response characteristics, automatic gain control circuits, or other amplitude sensitive systems.

The FG 504's phase lock mode feature lets you convert digital signals to high or low voltage sine waves, pulses, or triangles; ideal for locking the function generators output to a house or system frequency standard. With the DD 501 Digital Delay Generator in the "divide by n" mode, the FG 504 can be locked to your frequency reference at a lower frequency.

When your test and measurement problems require more waveforms for more applications, the high performance TM 500 Function Generators are a versatile solution singly or in combination with one another.

FUNCTION GENERATORS—

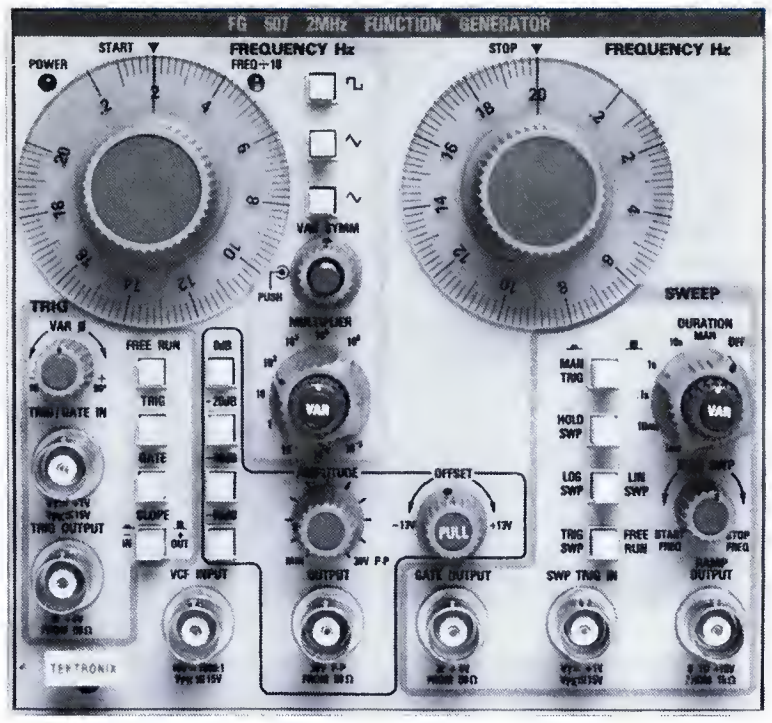
	NEW FG 501A	NEW FG 507
Waveforms	Sine, Square, Triangle, Pulse & Ramp with variable symmetry	
Symmetry	≤5% to ≥95% Variable	≤5% to ≥95% Variable
Frequency Range	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on
Dial Accuracy (% of Full Scale)	Within 3%	Within 3% Within 5% in sweep mode[2]
Custom Frequency Range	NO	NO
Frequency Stability (% of Full Scale)	≤0.05% for 10 min., ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature	
Amplitude: Open Circuit	30 V p-p	30 V p-p
Into 50 Ω	15 V p-p	15 V p-p
Attenuator	0 to −60 dB in 20 dB Steps >20 dB additional with AMPL control	0 to −60 dB in 20 dB Steps >20 dB additional with AMPL control
Offset: Open Circuit	±13 V dc, Step attenuator decreases offset	±13 V dc, Step attenuator decreases offset
Into 50 Ω	±6.5 V dc, Step attenuator decreases offset	±6.5 V dc, Step attenuator decreases offset
Pk Sig + Offset: Open Circuit	±15 V	±15 V
Into 50 Ω	±7.5 V	±7.5 V
Output Impedance	50 Ω	50 Ω
Amplitude Flatness (10 kHz ref, 50 Ω load) Sine wave	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz
Triangle	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz
Square wave	±0.5 dB 20 Hz to 2 MHz	±0.5 dB 20 Hz to 2 MHz
Sine wave Distortion (Maximum output, 50 Ω load)	≤0.25% 20 Hz to 20 kHz[2] ≤0.5% 20 kHz to 100 kHz Harmonics ≤ −30 dB, 100 kHz to 2 MHz	≤0.25% 20 Hz to 20 kHz[2] ≤0.5% 20 kHz to 100 kHz Harmonics ≤ −30 dB, 100 kHz to 2 MHz
Square Wave Response	≤25 ns rise/fall <3% p-p aberrations	≤25 ns rise/fall <3% p-p aberrations
Triangle Linearity (10% to 90%)	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz
Trigger Output	≥ +4 V from 50 Ω	≥ +4 V from 50 Ω
External Input	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%
Trigger	±90° variable start phase control	±90° variable start phase control
Gate	±90° variable start phase control	±90° variable start phase control
Phase Lock	NO	NO
Counted Burst	With DD 501	With DD 501
Internal Sweep	NO	Logarithmic or Linear, Separate Start/Stop Dials
Duration		1 ms to 100 s
External Trigger		+1 V ±20% trigger level ≈2 KΩ input impedance
Ramp Output	NA	≤0.3 V to +10 V from 1 KΩ ±5%
Gate Output		≥ +4 V from 50 Ω
Other Modes		Manual Sweep Trig Manual Sweep Sweep and Hold
Amplitude Modulation	NO	NO
Voltage Controlled Frequency (FM)	Up to 1000: 1 Frequency change with 10 V external signal. Slew rate ≥0.3 V/μs, 10 kΩ input impedance.	
Nominal Hz/Volt sensitivity	2 x Frequency MULTIPLIER setting	2 x Frequency MULTIPLIER setting
Output Hold Mode	NO	NO
Temperature[4]	0°C to +50° Operating, −55°C to +75°C non-operating	

[1] +15°C to +35°C ambient
[2] +20°C to +30°C ambient
[3] 20 Hz to 20 kHz modulation frequency
[4] FG 504 requires forced air circulation above +40°C

COMPARISON OF CHARACTERICS

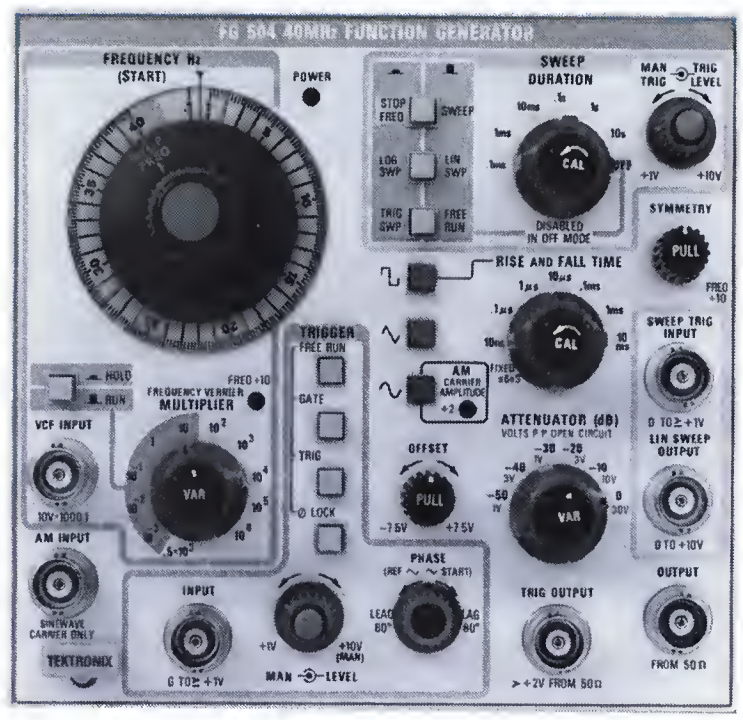
FG 504	FG 502	FG 503
Sine, Square, Triangle, Pulse & Ramp with variable symmetry	Sine, Square, Triangle Pulse, or Ramp	Sine, Square, Triangle
7% to 93% Variable	5%, 50%, 95% Fixed	50% Fixed
0.001 Hz to 40 MHz 4 MHz nominal with var symm on	0.1 Hz to 11 MHz Pulse & Ramp, 1.1 MHz	1.0 Hz to 3 MHz Usable 0.01 Hz to 5 MHz
Within 3% to 4 MHz[1] Within 6% to 40 MHz[1]	Within 3% to 1 MHz Within 5% to 10 MHz	Within 5%
Shipped with capacitor for 20 Hz to 20 kHz	NO	With user-installed capacitor
≤0.05% for 10 min., ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature		
30 V p-p	10 V p-p	30 V p-p
15 V p-p	5 V p-p	15 V p-p
0 to −50 dB in 10 dB steps <10 mV p-p with VAR conrtol	Variable control only	Variable control only
±7.5 V dc	±5 V dc	±7.5 V dc
±3.75 V dc	±2.5 V dc	±3.75 V dc
±20 V	±10 V	±15 V
±11.25 V	±5 V	±6 V
50 Ω	50 Ω	50 Ω
±0.5 dB 0.001 Hz to 40 kHz	±0.5 dB 20 Hz to 20 kHz ±1.5 dB 0.1 Hz to 11 MHz	±0.5 dB 20 Hz to 20 kHz ±2 dB 0.1 Hz to 3 MHz
±2 dB 40 kHz to 40 MHz ±0.5 dB to 20 MHz ±2 dB to 40 MHz	±3 dB referenced to Sine wave	±1 dB referenced to Sine wave
≤0.5% 20 Hz to 40 kHz[1] Harmonics: ≤ −30 dB 40 kHz to 1 MHz < −20 dB 1 MHz to 40 MHz	≤0.5% 10 Hz to 50 kHz[2] Harmonics ≤ −30 dB at all other frequencies	≤0.5% 1 Hz to 30 kHz ≤1.0% 30 kHz to 300 kHz ≤2.5% 300 kHz to 3 MHz
≤6 ns rise/fall fixed 10 ns to 100 ms variable ≤5% p-p +30 mV aberrations	≤20 ns rise/fall ≤3% p-p aberrations	≤60 ns rise/fall ≤3 p-p aberrations
≥99% 10 Hz to 400 kHz ≥95% 400 kHz to 40 MHz typ ≥ 98% 0.001 Hz to 10 Hz	≥99% 0.1 Hz to 100 kHz ≥97% 100 kHz to 1 MHz ≥95% 1 MHz to 11 MHz	≥99% 1 Hz to 100 kHz ≥95% 100 kHz to 3 MHz
≥ +2 V from 50 Ω	+2.5 V to 50 Ω load	+2.5 V to 600 Ω load
Impedance ≥10 kΩ Sensitivity ≤1 V p-p Trigger level −1 V to +10 V	Impedance ≈ 1 kΩ ≥ +2 V Gate Signal required	NO
20 MHz maximum ±80° start phase control to 10 MHz	NO	NO
	Fixed 0° start phase	NO
100 Hz to 40 MHz ±80° phase range	NO	NO
With DD 501	With DD 501	NO
Logarithmic or Linear, Separate Start/Stop Dials	NO	NO
0.1 ms to 100 s +1 V +10 V trigger level 1 V p-p sensitivity 0 to +10 V from 1 kΩ ±5% to 1 ms, ±10% ≤1 ms NO Manual Sweep Trig	N/A	N/A
100% with nominal 5 V p-p input Dc to 100 kHz modulation freq. <5% distortion to 4 MHz @ 70%[3] <10% distortion to 40 MHz @ 65%[3]	NO	NO
Up to 1000: 1 Frequency change with 10 V external signal. Slew rate ≥0.3 V/μs, 10 kΩ input impedance.		
4 x Frequency MULTIPLIER	1.1 x Frequency MULTIPLIER	3 x Frequency MULTIPLIER
0.001 Hz to 400 Hz	NO	NO
0°C to +50° Operating, −55°C to +75°C Non-operating		

Function Generators



FG 507

2 MHz Sweeping Function Generator



FG 504

40 MHz Function Generator

NEW FG 507

- 0.002 Hz to 2 MHz
- Includes all FG 501A Features
- Logarithmic or Linear Sweep
- Separate Start/Stop Frequency Dials
- Sweep Up or Down
- Sweep and Hold
- Manual Sweep

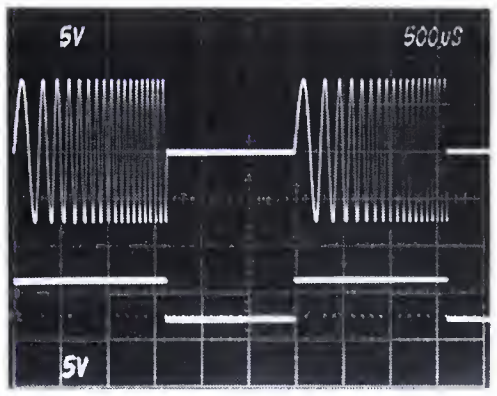
The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use, log and linear sweep capability.

The log sweep of the FG 507 is mathematically accurate and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503 Storage Oscilloscope. Separate start and stop frequency dials make frequency settings easy to set and interpret. The instrument can be internally or externally swept up or down and a third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep gate output can be used to gate (burst) the generator on for swept bursts. The sweep hold mode allows the generator to sweep to the stop frequency and remain there until released.

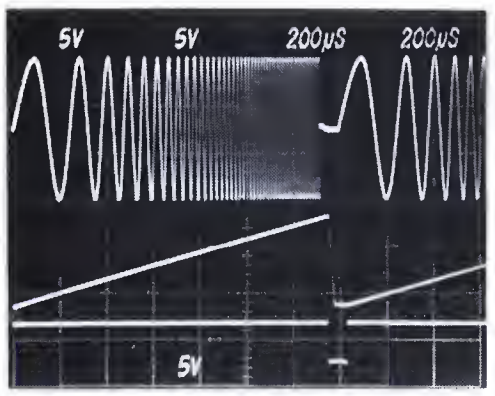
The accurate log/lin sweep capability of the FG 507 plus the low distortion, 0.25% over the audio range, make it ideally suited to audio testing.

ORDERING INFORMATION

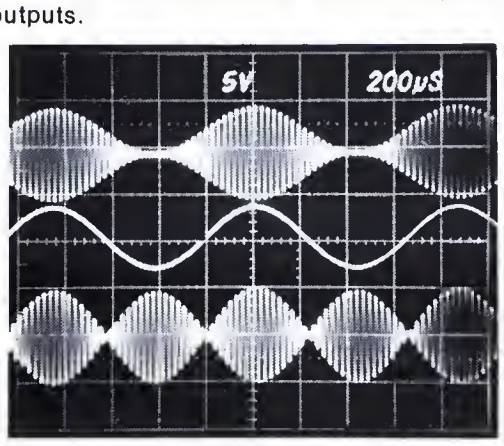
FG 507 2 MHz Sweeping Function Generator $1250
DD 501 Digital Delay $1075



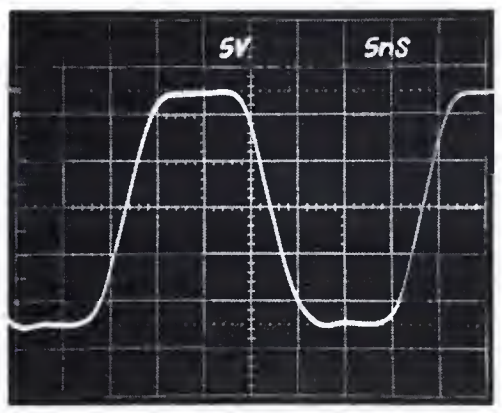
FG 507 triggered sweep mode with output gated on by sweep gate.



FG 507 in logarithmic sweep with sweep ramp and gate outputs.



True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.



FG 504 30 volt output with 6 ns rise and fall times for superior pulse waveforms.

FG 504

- 0.001 Hz to 40 MHz
- Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Rise and Fall Times and Symmetry Controls
- Logarithmic or Linear Sweep
- Separate Frequency Dials Set Lower (START) and Upper (STOP) Limits of Sweep
- Up to 30 V p-p Output
- Built-in Attenuator
- Am and Fm
- Phase Lock Mode
- External and Manual Trigger or Gate
- Counted Burst with DD 501

The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sine waves, as well as adjust phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be amplitude or frequency modulated by external signals.

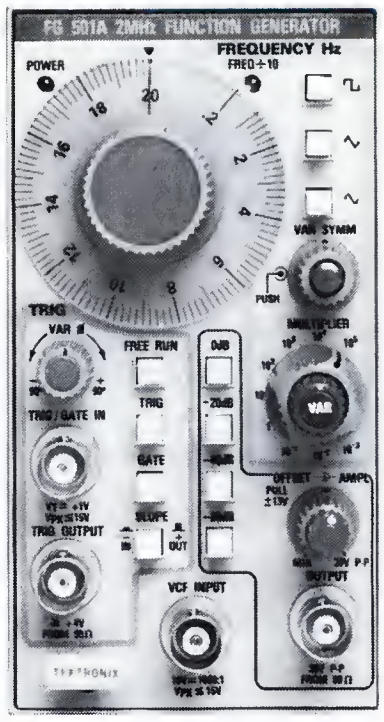
The FG 504 also provides trigger output, external voltage control input, and sweep output.

ORDERING INFORMATION

FG 504 40 MHz Function Generator . . $2150
FG 504T 40 MHz Function Generator . . $2420
(includes FG 504, TM 503 Mainframe, and 016-0195-03 blank panel)
DD 501 Digital Delay $1075

Ramp and Function Generators

FG 501A

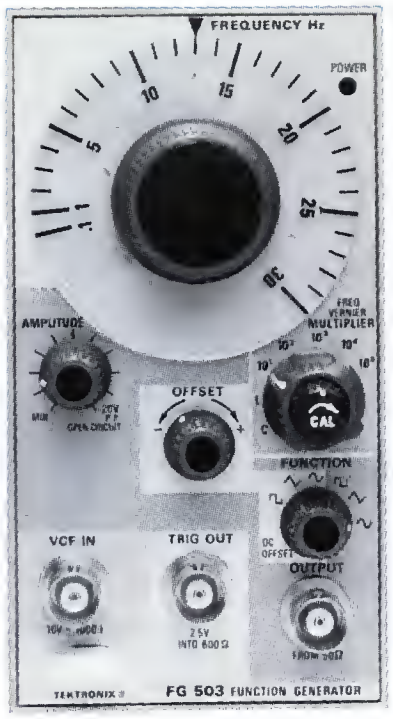


2 MHz Function Generator

FG 502

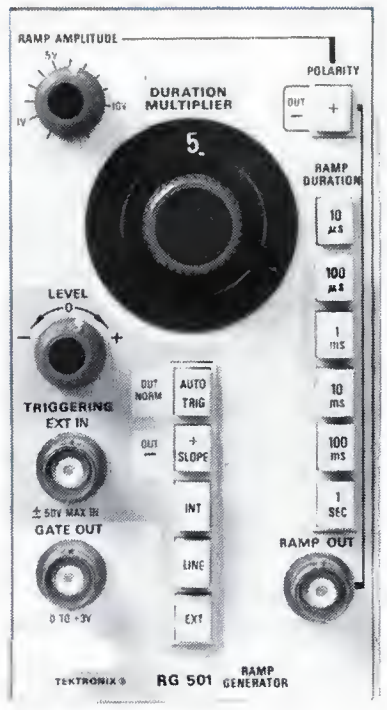
11 MHz Function Generator

FG 503



3 MHz Function Generator

RG 501



Ramp Generator

NEW FG 501A

- 0.002 Hz to 2 MHz
- 30 V p-p, ±13 V Offset
- 5% to 95% Variable Symmetry
- Trigger or Gate, ± Slope
- 60 dB Step Attenuator
- ≤0.25% Sinewave distortion
- ≤25 ns Rise/Fall

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms—sine wave, square wave, triangle, ramp, and pulse—at output levels up to 30 volts peak-to-peak with up to ± 13 volts of offset from a 50-ohm source. Waveform triggering and gating are provided with a variable phase control to permit up to ±90° of phase shift for generating haversines, sin² pulses, and haver triangles. A step attenuator provides 60 dB of output signal attenuation in 20 dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse risetime is ≤25 ns. Audio sinewave distortion is less than 0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low distortion sine waves, the FG 501A is uniquely appropriate for applications demanding audio signals.

Also useful in audio applications is the built-in 0 to 60 dB attenuator designed into the FG 501A.

The wide range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

ORDERING INFORMATION

FG 501A 2 MHz Function Generator . . . $680

DD 501 Digital Delay $1075

FG 502

- 0.1 Hz to 11 MHz
- Five Waveforms
- Vcf and Gated Burst

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. Voltage controlled frequency input permits the FG 502 to be used as a sweep generator. The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireline or radio remote control equipment and in certain phases of the telephone industry.

Order FG 502 11 MHz Function Generator $750

FG 503

- 1.0 Hz to 3 MHz
- Three Waveforms
- Vcf

The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multiplier steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V p-p can be developed across a 50 Ω load (20 V p-p open circuit). Selectable offset up to 3.75 V dc across 50 Ω (7.5 V dc open circuit) is also featured.

Order 503 3 MHz Function Generator . . $500

RG 501

- 10 μs to 10 s Ramp Duration
- Plus or Minus Output
- 10 V Amplitude
- Scope-type Trigger Functions
- Gate Out, TTL Compatible

RAMP

Ramp Duration — Decade ranges of 10 μs to 1 s, extends to 10 s with 1-10 duration multiplier. Accurate within 3% when multiplier is at X1 (multiplier not calibrated).

Ramp Amplitude — Continuously variable from 50 mV or less to at least 10 V, either polarity. Dc level between ramps, 0 V within 20 mV.

Gate — From a low state of 0 V, within 100 mV, the ramp gate rises to +3 V, within 0.6 V, in 100 ns or less. Fall time is 100 ns or less. Gate source impedance is nominally 160 Ω.

Ramp Output Characteristics — Minimum load resistance 3 kΩ; max load capacitance, 300 pF.

TRIGGERING

Auto Triggering — Provides free-running signal in absence of trigger. Locks automatically to trigger with a frequency above 20 Hz and at least 200 mV amplitude.

External Triggering — Sensitivity is at least 200 mV p-p, dc to 100 kHz. Input impedance approx 9.5 kΩ. 50 V (dc + peak ac) max input.

Internal Triggering — Same as external except that the trigger source is via the rear interface.

Line Trigger — Triggers at line frequency.

Trigger Level Range — ±1 V.

ORDERING INFORMATION

RG 501 Ramp Generator $500

Optional Accessory — Manual (One-Shot) Trigger Generator.

Order 016-0597-00 . . . . . $125

Current Probes, Amplifier

The TM 500 Signal Processors offer unique capabilities for solving electrical measurement and analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups, within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs: preamplification of low level signals; addition or removal of dc offset; integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V p-p) to suggest a few.

The AM 503 is specifically designed to work with the P6303/P6302 Current Probes (up to 50 MHz), and incorporates a feature that limits the bandwidth to 5 MHz, allowing elimination of unwanted transients or noise. An illuminated knob skirt indicates calibrated current per division.

To use these current probes to their full bandwidth, the bandwidth of the oscilloscope should be greater than the probe/AM 503 combination. For example, with the P6302/AM 503, a scope such as the 80 MHz SC 504 can be used to obtain full bandwidth capability.

The P6302/AM 503 and P6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. The probes utilize inductive coupling eliminating the need to break the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset, low frequency and high frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to one volt. High performance features of the AM 502 are a dc to 1 MHz bandwidth and 100 dB common-mode rejection ratio.

The AM 501 Operational Amplifier's output power (±40 volts and ±50 mA across 800 Ω loads) is more than adequate for most electronic and electro-mechanical applications. This high-output unit has front panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentation, integration, summing and impedance transformation problems.

Our extremely versatile AF 501 Bandpass Filter/Amplifier has a center frequency that is one-knob tunable over the entire audio range (3 Hz to 35 kHz). It's switch-selectable in broad (Q=5, ≈ ⅓ octave) and narrow (Q=15, ≈ 1/10 octave) bandwidths. It provides sine wave generation to 35 kHz and flat signal amplification to 50 kHz. You can select amplification from 1 to 500 in a 1-2-5 sequence in both filter and amplifier modes.

AM 503

Current Probe Amplifier

AM 503

Displays Current Signals on an Oscilloscope

Current Range, Maximum Current, and Bandwidth Determined by the Probe Used

The AM 503 is a plug-in modular current-probe amplifier that operates in TM 500 Mainframes. It allows display of current on any oscilloscope with 10 mV/div sensitivity, 50 ohm or 1 megohm input, and (for performance to full bandwidth specifications) at least 75 MHz when using the P6302 or 50 MHz when using the P6303. The amplifier attenuator is calibrated in 12 steps with a 1, 2, 5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to FULL (where it is limited by the probe in use) or to 5 MHz. Coupling may be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.

ELECTRICAL CHARACTERISTICS

(AM 503 Current Probe Amplifier with P6302 Probe or P6303 Probe)

Maximum Input Current — 20 A (dc + peak ac) for P6302. 100 A (dc + peak ac) for P6303.

Maximum Voltage for Current Under Test (Bare Conductor) — 500 V (dc + peak ac) for P6302. 700 V (dc + peak ac) for P6303.

Bandwidth (−3 dB) — Dc to at least 50 MHz with P6302. Dc to at least 15 MHz with P6303.

Rise Time (Full Bandwidth) — 7 ns or less with P6302. 23 ns or less with P6303.

Deflection Factor — 1 mA/div to 5 A/div for P6302. 20 mA/div to 50 A/div for P6303. In a 1, 2, 5 sequence for both probes.

Attenuator Accuracy — Within 3% of indicated CURRENT/DIV for both probes.

INCLUDED ACCESSORIES WITH AM 503

50 Ω cable w/BNC (012-0057-01), 50 Ω terminator (011-0049-01).

Order AM 503 Current Probe Amplifier . $775

P6303 Current Probe

100 A Ac and Dc Current Measurements

Dc to 15 MHz Bandwidth

Peak Pulse Measurements to 500 A

Ac or Dc Coupling

1 inch by 0.830 inch Jaw Opening

One-hand Operation

This new clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the P6303 can easily be clamped to cables up to 0.830 in. Other measurement parameters of the probe include: 100 amps continuous and 500 amps peak.

By combining an oscilloscope, such as the SC 504, with the P6303/AM 503 Current Probe Amplifier in a TM 500 Mainframe you will have a convenient and compact high current amplification/measurement system.

Order P6303 Current Probe
010-6303-01 . . . . . $745

P6302 Current Probe

1 mA to 20 A Current Measurement Range

50 A Peak Pulse Measurements

Dc to 50 MHz Bandwidth

When a P6302 Current Probe is used with the AM 503 Current Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A not to exceed a product of 100 A μs. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

Included Accessories — 5 inch ground lead (175-0124-01), 3 inch ground lead (175-0263-01), two alligator clips (344-0046-00).

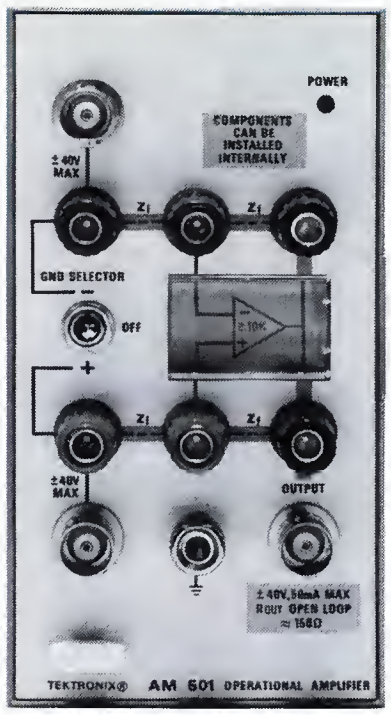
Order P6302 Current Probe
010-6302-01 . . . . . $390

Amplifiers

AM 502

Differential Amplifier

AM 501



Operational Amplifier

AF 501

Bandpass Filter/Amplifier

AM 502

1 to 100,000 Gain

100 dB Cmrr

Selectable Upper and Lower −3 dB Points

Dc to 1 MHz Maximum Bandwidth

Adjustable Dc Offset

The AM 502 Differential Amplifier features wide bandwidth; high cmrr; and selectable calibrated gain and filtering. Well-suited for general-purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

AMPLIFIER

Gain — 100 to 100,000, 1-2-5 sequence, accurate within 2%. 1X gain obtained by 100X attenuation.

Hf −3 dB POINT — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. Upper −3 dB point reduces to 500 kHz at 50 k gain, 250 kHz at 100 k gain.

Hf −3 dB POINT — Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits −3 dB point to 2 Hz or less.

Dc Offset — At least ±1 V.

Normal-Mode Cmrr — At least 100 dB, dc to 50 kHz, range, ±5 V.

÷ 100 Mode Cmrr — At least 50 dB, dc to 50 kHz, range, ±50 V.

Max Input Voltage — Normal mode dc coupled: 15 V (dc + peak ac). ÷ 100 Mode dc coupled: 350 V (dc + peak ac). Ac coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

Input R and C — 1 MΩ paralleled by approx 47 pF. Input impedance can be increased to a FET input via a simple internal jumper change.

OUTPUT

Max Output — ±5 V, ±20 mA, output resistance is 5 Ω or less.

Min Load Impedance — 250 Ω.

Input Gate Current — Typically 50 pA at 25°C.

Max Noise — ≤25 μV or less (tangentially measured) referred to input NORM mode.

Overage — Front-panel lamp indicates most overrange conditions.

Max Voltage Drift — 100 μV/°C referred to input NORM mode.

Order AM 502 Differential Amplifier $975

AM 501

±40 V, 50 mA Output

Open Loop Gain 10,000

50 V/μs Slew Rate

Symmetrical Differential Design

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 Modules. Components may be added externally or internally making it ideal for teaching operational amplifier theory.

OPERATIONAL AMPLIFIER

Open Loop Gain — At least 10,000 into 800 Ω load.

Unity Gain Bandwidth — At least 5 MHz into 800 Ω load.

Common-Mode Rejection Ratio — At least 10,000 to 1 at 60 Hz.

Slew Rate — At least 50 V/μs into a 800 Ω load.

INPUT

Common-Mode Input Voltage Range — At least ±40 V.

Input Leakage Current — Less than 500 pA at 20°C.

Equivalent Input Drift — Less than 100 μV/°C.

Equivalent Input Noise — Less than 10μV RMS.

Max Differential Input Voltage — 80 V.

OUTPUT

Voltage Range — At least ±40 V.

Current Limit — At least ±50 mA.

Open Loop Output R — Approx 150 Ω.

Order AM 501 Operational Amplifier . . $490

OPTIONAL ACCESSORY

Terminal Accessory Adapter Kit (013-0146-00) $22

AF 501

Tunable Bandpass Filtering to 35 kHz

Signal Amplification to 50 kHz

Sine-wave Generation to 35 kHz

Strobe Trigger Synced to Oscillator or Filter Output

Dial Readings In Hz or Cycles per Minute

The AF 501 is a Bandpass Filter/Amplifier, ac-coupled amplifier and sine-wave generator. Used alone or in conjunction with other TM 500 Instruments, the AF 501 is a highly versatile and accurate signal analysis tool. Developed primarily for the mechanical measurement domain, the AF 501 can be used as a manual-sweep spectrum analyzer for complex sound and vibration signals. Single-frequency tuning faciltates isolation of 1X rpm signals in dynamic balancing, or viewing higher order disturbances on a CRT monitor. An output pulse, synced to the filter or oscillator output signal, is available for triggering a stroboscope or oscilloscope and for frequency counting.

BANDPASS FILTER

Center Frequency Range — 3 Hz to 35 kHz in 4 decade steps.

Frequency Dial Error — <5% dial setting between 3-20, <10% dial setting between 20-30.

Frequency Multiplier — X1, X10, X100, X1 k.

Phase Shift — <10° at tuned frequency below 5 kHz.

Dial Range — 3 to 40 Hz/180-2400 cpm.

Max Filter Attenuation — >70 dB.

Filter Selectivity — Broad: Q = 5 ±1.
Narrow: Q = 15 ±5.

Bandwidth at Half-power Points —

$$\Delta F_{-3\,dB} = \frac{\text{center frequency}}{Q}$$

Gain Range — 1-500; 1-2-5 sequence.

Gain Accuracy — ± 3 dB (Broad), ± 5 dB (Narrow).

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Max Dc Input Voltage — ± 100 V.

Output Voltage — 20 V p-p (max freq times amplitude = 400 V kHz).

Output Current—20 mA p-p max (at 20 V p-p).

Output Impedance — <1 Ω.

AMPLIFIER

Gain — 1 to 500; 1-2-5 sequence.

Gain Accuracy — ±3%.

Bandwidth — <0.5 Hz to >50 kHz (at 3 dB point).

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Noise — <25 mV rms (referred to output).

Output Voltage — 20 V p-p (max freq times amplitude = 400 V kHz).

OSCILLATOR

Sine Wave Out Range — 3 Hz to 35 kHz.

Dial Range — 3 to 40 Hz/180-2400 cpm.

Output Amplitude — 1, 2, or 5 V p-p ±20%, depending on gain position.

Waveform Distortion — <3%.

Output Current — Max 50 mA p-p.

Output Impedance — <1 Ω (within 50 mA output current limit).

TRIGGER OUTPUT

Pulse Amplitude — >10 V.

Pulse Duration — 10 ±5 μs.

Min Signal Required — 500 mV, p-p

Rise and Fall Time — <1 μs.

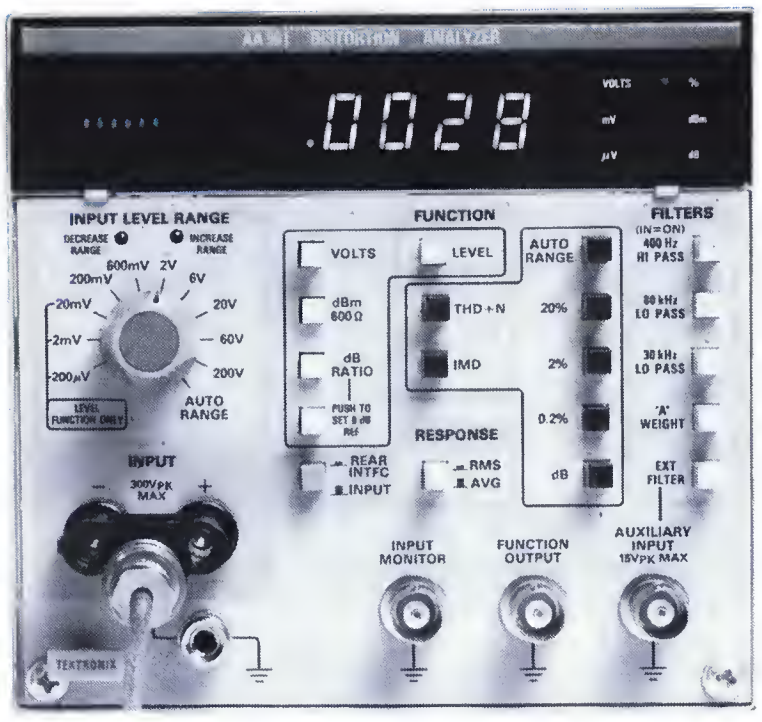
Output Impedance — ≈50 Ω.

Order AF 501 Bandpass Filter/Amplifier $775

Distortion Analyzer

AA 501 NEW
Distortion Analyzer

- Fully Automatic: no level setting, tuning or nulling
- Total System Harmonic Distortion plus Noise (THD + N) — 0.0025%
- Extremely Low Residual Noise — <3 μV
- Novel Analog-like "bar graph" plus Complete Digital Readout
- True RMS or Average Responding in All Modes
- Intermodulation Distortion (option) to SMPTE, DN, and CCIF
- Differential Input



Used together, the AA 501 Distortion Analyzer and SG 505 Oscillator provide the easiest solution to your distortion measurement needs. The AA 501 and SG 505 combination permits harmonic distortion, intermodulation distortion, frequency response, gain/loss, and signal-to-noise ratio measurements to be accomplished with minimal operator skill level. At the same time, both instruments feature state-of-the-art performance in residual noise and distortion.

With the introduction of the Tektronix AA 501 Distortion Analyzer and SG 505 Oscillator, complex distortion measurements become a totally automated process. All steps which previously required several minutes of skilled operator time, such as level setting, tuning and nulling are now done quickly, precisely, and automatically by the AA 501's internal circuitry.

Because the AA 501 Distortion Analyzer and SG 505 Oscillator are two separate plug-ins they may be used as a powerful package in the same mainframe or apart. For instance, the SG 505 can be left in a rackmount mainframe at a broadcast station while the AA 501 is transferred to a portable mainframe and taken to the transmitter site for distortion measurements. Together or thousands of miles apart, the AA 501 Distortion Analyzer automatically tunes to the oscillator's (SG 505 or your present oscillator) signal with no operator assistance required. The SG 505's frequency or level can be changed repeatedly and the AA 501 will automatically accommodate these changes as they occur.

The AA 501 Distortion Analyzer makes complex measurements easier than ever with no compromise in performance. The AA 501 measures total harmonic distortion, gain/loss, signal to noise ratio, and audio levels. With Option 01 the ability to measure intermodulation distortion is added. These measurements are accomplished automatically, with no level setting, nulling, or meter ranging to be done by the operator. The measurement result appears on an LED display with no additional scale factoring necessary.

Residual distortion, when used with the SG 505, is 0.0025%. Residual noise in the analyzer is less than 3 μV.

To measure Total Harmonic Distortion plus noise (THD+N) or Intermodulation Distortion (IMD) the operator simply feeds the audio signal to the analyzer. The AA 501 automatically locks on the signal, sets the proper level, and switches in the proper filter. In the THD+N measurement the filter nulling is totally automatic, with no presetting of controls required. When used with a separate oscillator, no loss of automatic features is experienced.

The optional IMD mode measures signals to any of three usual standards: SMPTE, DIN, or CCIF. Internal circuitry identifies the standard being used and configures itself to display the appropriate results.

The AA 501 has a 0 dB reference memory. This feature allows an audio level to be set to 0 dB and all subsequent signal levels are compared to it. The result is expressed in dB on the display.

Selection from the front panel allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The digital voltmeter is auto ranging on all scales, from the lowest, 200 μV full scale, to the highest, 200 V full scale.

Four filters are included and can be switched in and out from the front panel. They are: 400 Hz high pass, 30 kHz low pass, 80 kHz low pass (all 18 dB per octave Butterworth), and "A" weighting. For user convenience, an extra position on the filter switch provides for an external, user provided filter.

The AA 501 and SG 505 can be configured with several other audio-quality instruments from Tektronix. For instance, the FG 507 Sweeping Function Generator features a low distortion sine wave output (up to 2 MHz) and a log/lin sweep making it an ideal signal source in a communications test set. The FG 501A 2 MHz Function Generator is specifically designed for those audio/communications measurements not demanding log/lin sweep capability. (See pages 202, 203 for complete specifications and information on the FG 507 and FG 501A).

To complete an audio test set add the DM 502A Digital Multimeter with an accuracy of 0.1% dc volts and seven functions including, autoranging dB and temperature (see page 186). The SC 503 Storage Oscilloscope is also ideal for audio/communications applications with a bandwidth of 10 MHz and X-Y capability. Storage permits slow audio sweeps to be displayed or enables the long-term monitoring of peak audio levels (see page 218).

THD
Completely automatic Total Harmonic Distortion (THD) measurements to specified accuracy in 7 seconds or less.

LEVEL
Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

IMD (OPTION 01)
Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.

DISTORTION FUNCTION

Fundamental Frequency Range — 10 Hz to 100 kHz automatically tuned to input frequency.

Distortion Ranges — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

Detection — Average or true RMS for waveforms with crest factor ≤3.

Accuracy (readings ≥4% of range) — 20 Hz to 20 kHz ±1 dB. 10 Hz to 100 kHz +1, −3 dB. (Accuracy is limited by residual THD+N and filter selection.)

AA 501/SG 505 System Residual THD+N*
V_{in} ≥250 mV, (all distortion, noise, and nulling error sources combined).
20 Hz to 20 kHz.
≤0.0025% (−92 dB) Average Response with 80 kHz filter.
≤0.0032% (−90 dB) RMS Response with 80 kHz filter.
10 Hz to 50 kHz
≤0.0056% (−85 dB) RMS or Average Response.
50 kHz to 100 kHz
≤0.010% (−80 dB) RMS or Average Response.

Typical AA 501 Residual THD Contribution
10 Hz to 20 kHz ≤0.0018% (−95 dB).
20 kHz to 50 kHz ≤0.0032% (−90 dB).
50 kHz to 100 kHz ≤0.0071% (−83 dB).

Typical Fundamental Rejection — At least 10 dB below specified residual THD+N or actual signal THD, whichever is greater.

Minimum Input Level — 60 mV (−22 dBm).

*From +30°C to +50°C derate by a factor of 1.25 (+2 dB).

LEVEL FUNCTION

Modes — Volts, dBm (600 Ω), or dB ratio with push to set zero dB reference.

Detection — Average or true RMS for waveforms with crest factors ≤3.

Level Ranges — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

Accuracy —

Frequency	Volts	dBm or dB ratio
20 Hz to 20 kHz	±2%	±0.3 dB
10 Hz to 100 kHz	±4%	±0.5 dB

(V_{in} ≥100 μV, level ranging indicators extinguished).

Bandwidth — ≥300 kHz.

Residual Noise — ≤3.0 μV (−108 dBm) with 80 kHz and 400 Hz filters.
≤1.5 μV (−114 dBm) with "A" weighting filter.

FUNCTION

INTERMODULATION DISTORTION (OPTION 01)

SMPTE and DIN Tests — Lower frequency range: 50 Hz to 250 Hz.
Upper frequency range: 3 kHz to 100 kHz.
Level ratio range: 1:1 to 5:1 (lower:upper).
Residual IMD: ≤0.0025% (−92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.

CCIF Difference Frequency — Frequency range: 4 kHz to 100 kHz.
Difference frequency range: 50 Hz to 1 kHz.
Residual IMD: ≤0.0018% (−95 dB) with 14 kHz and 15 kHz.
Minimum input level: 60 mV (−22 dBm).

Accuracy — ±1 dB.

ALL FUNCTIONS

Filters — 400 Hz high pass: −3 dB at 400 Hz ±5%; at least −40 dB rejection at 60 Hz.
80 kHz low pass: −3 dB at 80 kHz ±5%.
30 kHz low pass: −3 dB at 30 kHz ±5%.
"A" weighting: Meets specifications for Type 1 sound level meters (ANSI S 1.4, IEC Recommendation 179).
EXT: Allows connection of external filters.

Input Impedance — 100 kΩ ±2%, each side to ground, fully differential.

Maximum Input — 300 V pk, 200 V RMS either side to ground or differentially.
Fully protected on all ranges.

Common Mode Rejection — ≥50 dB at 50 or 60 Hz. Typically ≥40 dB to 300 kHz.

FRONT PANEL SIGNALS

Input Monitor — Provides constant amplitude version of signal applied to input. Output voltage: 1 V RMS ±10% for input signals greater than 50 mV. Source impedance: 1 kΩ ±5%.

Function Output — Provides a scaled sample of selected function signal (1000 count display = 1 V RMS ±3%). Source impedance: 1 kΩ ±5%.

Auxiliary Input — Provides input to detector circuit when EXT FILTER button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

REAR INTERFACE SIGNALS

Rear INTFC Input — Front panel selected. Same as main INPUT except, maximum signal input is limited to 42 V pk, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion performance.)

Monitor — Same as front panel INPUT MONITOR.

Function Output: Same as front panel FUNCTION.

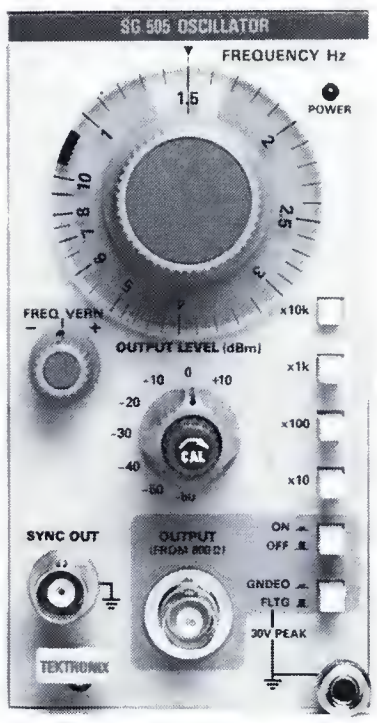
Auxiliary Input — Same as front panel AUXILIARY INPUT.

Converter Output — Dc output of selected response converter. 1 V ±5% for 1000 count display. Source impedance: 500 Ω ±5%.

dB Output — Dc output of logarithmic dB converter. 10 mV ±5% per 1 dB of display. Source impedance: 1 kΩ ±5%.

ORDERING INFORMATION

AA 501 Distortion Analyzer **$1875**
Option 01 Intermodulation Distortion . . . . . **Add $600**



SG 505

Oscillator

SG 505

10 Hz to 100 kHz Sine Wave (typically 9 Hz to 110 kHz)

Ultra-Low Distortion—0.0008% THD (typically 0.0003%)

Floating Output—600 Ω Source

Vernier Frequency Control

Isolated and Ground Referenced Sync Output

Calibrated Output into 600 Ω— +10 dBm to −60 dBm

The SG 505 Oscillator: it features the lowest distortion level commercially available today in the 10 Hz to 110 kHz band (0.0008% between 20 Hz and 20 kHz). The SG 505 assures you of freedom from residual distortion effects, particularly critical when making audio and communication measurements. And, this extremely low distortion is coupled with many designed-in convenience features. For instance, the main signal output may be floated to help avoid interference due to troublesome ground loops, or it may be ground referenced. The SG 505 also features an isolated and ground referenced sync output. This allows you to monitor the phase or the frequency of the output of the oscillator without disturbing the floating output of the main signal.

MAIN OUTPUT

Frequency Range — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dial setting (with Vernier at center). Vernier Range is at least ±1% of frequency setting.

Calibrated Output — Selectable from +10 dBm to −60 dBm into 600 Ω in eight 10 dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to less than −10 dB from calibrated position.

Amplitude Response — Level flatness ±0.1 dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding −60 dB output level range).

Harmonic Distortion — Less than 0.0008% (−102 dB) THD from 20 Hz to 30 kHz (typically 0.0003% 20 Hz to 20 kHz); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0032% (−90 dB) THD from 50 kHz to 100 kHz ($R_L \geq 600\ \Omega$).

Output Impedance — 600 Ω ±2%; floating or grounded through approximately 30 Ω. Output impedance does not change with OUTPUT ON/OFF selection. Maximum floating voltage ±30 V peak.

Max Output Voltage — At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or + 12.2 dBm) into 600 Ω.

SYNC OUTPUT

Signal — 200 mV RMS ±20% sine wave.

Frequency — Same as main output.

Impedance — 1 kΩ ±10%, ground referenced and isolated from main Output.

REAR INTERFACE SIGNALS

Buffered Main Output — Buffered version of actual output signal from front panel connector. Approximately 300 Ω Output impedance.

Sync Output — Same as front panel SYNC OUTPUT except output impedance is approximately 50 Ω.

OPTION 01 IM TEST SIGNAL

Selecting the IM Test Signal causes a LF sinewave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

Lf Frequency — Internally selectable 60 Hz (±1 Hz) or 250 Hz (±3 Hz).

Main Output — Composite peak-to-peak output within 0.2 dB of normal oscillator mode output.

Residual IMD — Typically less than 0.0005% from 2.5 kHz to 10 kHz.

Sync Output — Lf signal component only, 200 mV RMS ±20%.

ORDERING INFORMATION

SG 505 Oscillator **$675**
Option 01 (IM Test Signal) . . . . . **Add $125**

SG 502

Oscillator

SG 502

5 Hz to 500 kHz Sine and Square Waves

Low Distortion Sine Wave

5 V RMS Open Circuit—600 Ω Source

0-40 dB Output Variable Plus 0-70 dB in 10 dB Steps

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes where the extremely low distortion levels of the SG 505 are not required. Other SG 502 features include 70 dB amplitude control plus a simultaneous fixed amplitude square wave.

SINE WAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to less than 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response — Flatness is 0.3 dB over entire range (1 kHz reference).

Attenuation — Selectable from 0 dB to 70 dB in 10, 20, and 40 dB steps with pushbuttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to −40 dB.

Harmonic Distortion — Less than 0.035% (−70 dB) from 20 Hz to 50 kHz. Less than 0.1% (−60 dB) over the remaining frequency range ($R_L \geq 600\ \Omega$).

Hum and Noise — Less than 0.1% of rated output.

Max Output Voltage — 5 V RMS open circuit; 2.5 V RMS into 600 Ω.

Output Impedance — 600 Ω, grounded.

SQUARE WAVE

Frequency Range — Same as sine wave. The square wave switches on the 0° phase of sine out.

Rise and Fall Time — 50 ns or less.

Amplitude — +5 V, fixed, open circuit.

Output Impedance — 600 Ω, grounded.

SYNC INPUT

Oscillator can be synchronized to external signal, Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

Input Impedance — 10 kΩ.

Order SG 502 Oscillator **$675**

Oscilloscope Calibration Instruments

Downtime is one problem no production manager can afford . . . and the time service engineers spend transporting oscilloscopes from the job site to the calibration bench is wasted time. In the end, for a production house or manufacturing unit, the production line is the bottom line.

And now, with the introduction of the CG 551AP, the Tektronix Oscilloscope Calibration Instruments come even closer to solving the entire range of oscilloscope calibration problems.

The CG 551AP is the computerized solution to large-scale scope calibration needs. The CG 551AP can be used as part of a computerized system to calibrate and verify all of the major oscilloscope parameters. The CG 551AP is specifically designed for use at those installations where many oscilloscopes are used and maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

In addition to the CG 551AP, TM 500 offers a complete set of calibration instruments which can be configured into a portable test set for in-field oscilloscope service and calibration.

These TM 500 Oscilloscope Calibration instruments offer the widest range of standard amplitude square waves, fastest rise times, lowest abberrations, fastest time marks and widest frequency range of leveled sine waves available today.

In addition to its crystal-controlled mode, the TG 501 provides a variable mode. This means you can quickly adjust and accurately align the time mark spacing to your oscilloscope's graticule marks, and read the percentage timing error directly off the TG 501's digital display.

Our PG 506 Calibration Generator offers TM 500 portability plus state-of-the-art performance features. With the PG 506 in the amplitude calibration mode, you can generate a 1 kHz square wave and vary its amplitude around the calibrated level until the square wave aligns with your oscilloscope's verticle graticule divisions. At that point, you can read the scope deflection error right off the PG 506's digital display in percentage high or low.

TM 500 leveled sine wave generators, SG 503 and SG 504, round out a scope calibration and verification package. These generators provide leveled sine waves for bandwidth checks (−3 dB points) and triggering performance checks.

The SG 503 is a general-purpose leveled sine-wave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands.

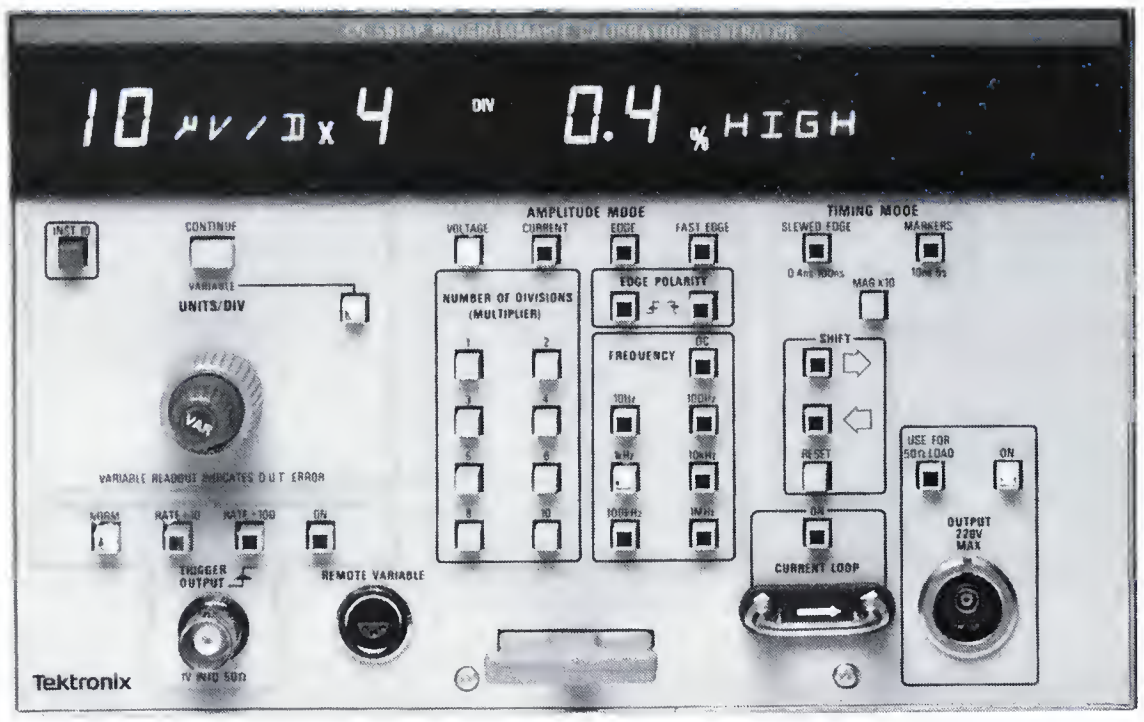
Another TM 500 plug-in, the SG 502 Oscillator, could also benefit calibration applications where verification of low frequency roll off in ac modes and performance measurement of low frequency reject triggering modes is required.

For features that allow time and error reduction for on-the-job oscilloscope evaluation, our TM 500 Calibration Instruments are the best value on the market today.

Tektronix offers maintenance training classes on the TM 500 Calibration Systems Package and a new multi-media training package on Digital Counter and Meter Concepts. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

OSCILLOSCOPE CALIBRATION INSTRUMENTS CHART

	CG 551AP Programmable Calibration Generator	PG 506 Calibration Generator	TG 501 Time Mark Generator	SG 503 Signal Generator	SG 504 Signal Generator
Primary Functions	Amplitude Calibration 400 μV to 200 V Time-base Calibration 400 ps to 5 s	Amplitude Calibration 200 μV to 100 V	Time-base Calibration 1 ns to 5 s	Bandwidth Calibration 250 kHz to 250 MHz	Bandwidth Calibration 245 MHz to 1050 MHz
Secondary Functions	Rise time and transient response testing, attenuator compensation testing. Testing oscilloscope nonlinearity.	Rise time and transient response testing, attenuator compensation testing.	Testing oscilloscope nonlinearity	General leveled rf signal source	General leveled rf signal source with frequency modulation capability



Programmable Oscilloscope Calibration Generator

NEW CG 551AP

GPIB Product

The CG 551AP is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk, Listen.

The TEKTRONIX CG 551AP is a microprocessor-based oscilloscope calibration generator that is fully programmable. It can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

- **Vertical Gain**
- **Horizontal Timing and Gain**
- **Vertical Bandwidth/Pulse Characteristics**
- **Probe Accuracy and Compensation**
- **Current Probe Accuracy**
- **Calibrator Output Accuracy**

The CG 551AP's front panel features a diversity of functions, many of which represent a new state of the art in calibration performance. All these functions are programmable through a controller via the GPIB (General Purpose Interface Bus, IEEE-488). A "LEARN" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system provides step-by-step instructions to the operator, thus significantly reducing the skill level required.

Many of the calibration and test steps previously performed by the operator can now be transferred to the computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program sends control-setting information to the CG 551AP, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions on the CRT are automatically coordinated with the calibration signals going into the oscilloscope from the CG 551AP. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 551AP return error or deviation information to the controller, where it is compared with preprogrammed reference values for the oscilloscope; out-of-tolerance values are flagged. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as the hard copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

To develop the specific software for testing and calibration of different oscilloscopes, Tektronix has designed the CG 551AP ScopeCal Procedure Development Aid program. This program assumes you are not familiar with programming. To incorporate the calibrator's knowledge into the system software, the ScopeCal Procedure Development Aid program uses two simplified techniques. First is a series of questions that appear on the controller's CRT. The calibrator's answers to these questions form the foundation for the software that will eventually run the system. Second is the CG 551AP's "LEARN" mode, which allows the calibrator to set functions and ranges using the CG 551AP's front panel controls (as would have been done on older generations of manually-operated calibration generators), and have these entries automatically transferred to the controller for use in forming the program. Once the calibrator has completed interacting with the ScopeCal Procedure Development Aid program, all the acquired information is automatically converted into a simpler program format that will govern the system's operation when a less experienced operator is using it. This operator-oriented program will take care of all the CG 551AP's settings, while giving the

```
STEP #32    7B53A  1us TIMING

TIME/DIV          1us          DLYD TRIGGER:
DLY TIME          1us
VAR               CAL          SLOPE          +
MAG               X1           CPLG           AC
DLY TIME MULT.    1.0          SOURCE         INT
                               LEVEL          CW DETENT
MAIN TRIGGER:                  POSITION       CENTERED
                               FINE POSN.     CENTERED
MODE              AUTO
CPLG              AC
SOURCE            EXT
SLOPE             +
LEVEL             CENTERED

==========================================================================

ADJUST:   NORIZONTAL POSITION  to align #1 marker with the first
          vertical graticule line.

ADJUST:   CG 551AP  VARIABLE control until ninth marker coincides
          with the  ninth vertical graticule line.

PRESS:    CG 551AP  CONTINUE button.
```

Instructions to operator on CRT screen of 4052 Graphics Computing Controller.

```
8. WILL YOU WANT TO LOG DATA FROM THIS PROCEDURE?   YES
9. TO WHAT DEVICE DO YOU WANT DATA TO BE LOGGED?
                1. TERMINAL SCREEN
                2. TERMINAL TAPE DRIVE
                3. LINE PRINTER
                4. GPIB DEVICE
   ENTER 1, 2, 3, OR 4.   4
10.  WHAT IS THE ADDRESS OF THE DEVICE?   7
11. IN WHAT FORMAT SHALL DATA BE LOGGED?
                1. STEP NUMBER, PASS/MARGINAL/FAIL
                2. STEP NUMBER, IDEAL VALUE, PERCENT DEVIATION
                3. STEP NUMBER, STEP LABEL, IDEAL VALUE,
                   PERCENT DEVIATION, TOLERANCE LIMITS
   ENTER 1, 2, OR 3.    2
```

4052 Graphics Computer Controller showing the development of a typical calibration procedure using the ScopeCal Procedure Development Aid program.

operator a step-by-step description of any settings that must be made on the oscilloscope. It will also accept data from the CG 551AP or the controller keyboard.

The CG 551AP is designed to greatly reduce your maintenance costs. Built-in self test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

VOLTAGE (AMPLITUDE MODE)

The standard voltage is used to calibrate vertical display accuracy.

Range — 40 μV to 200 V (1-2-5 steps with multiplier).

Multipliers — 1,2,3,4,5,6,8,10 divisions.

Polarity — Positive from ground.

Accuracy — ±0.25% ±1 μV.

Frequency — 40 mV to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: 10 Hz to 100 kHz, or dc. 12 V to 200 V: 10 Hz to 10 kHz, or dc.

Droop — ≤1%.

Variable Range — ±9.9%.

CURRENT (AMPLITUDE MODE)

The standard current is used to calibrate current probes.

Range — 1 mA to 100 mA (1-2-5 sequence).

Multipliers — 1,2,3,4,5,6,8,10.

Accuracy — ±0.25% ±2 μA.

Frequency — Dc or 10 Hz to 1 MHz (decade steps).

Droop — ≤1%.

Variable Range — ±9.9%.

LOW EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

Range — 20 mV to 1 V (1-2-5 steps with multipliers).

Multipliers — 1,2,3,4,5,6,8,10.

Polarity — Positive or negative transitions to ground.

Risetime (Falltime) — <1.3 ns.

Abberrations — ±2%.

Long Term Flatness — ±0.5% after first 10 ns.

Frequency — 10 Hz to 1 MHz (decade steps).

Variable Amplitude Range — > ±10% from nominal.

Termination — 50 Ω.

FAST EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

Range — 1 V (multiplier at X1).

Polarity — Positive to ground.

Risetime — <100 ns.

Aberrations — ±2%.

Long Term Flatness — ±0.5% after first 500 ns.

Frequency — 10 Hz to 100 kHz (decade steps).

Variable Amplitude Range — > ±10% from nominal.

Termination — ≥10 kΩ.

MARKERS (TIMING MODE)

The markers obtained in this mode are used to calibrate oscilloscope time bases.

Range — 10 ns to 5 sec (1-2-5 steps).

X10 Magnifier — Increase marker rate by a factor of ten (0.1 μs to 5 sec range).

Accuracy — ±0.01% (optional TCXO ±0.0003%).

Amplitude — 1 V minimum into 50 Ω.

Variable Range — ±9.9%.

SLEWED EDGE (TIMING MODE)

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.

Range — 0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).

X10 Magnifier — Increases Slewed Edge rate by a factor of ten (5 ns to 100 ns range).

Accuracy — ±0.01% (Optional TCXO ±0.0003%).

Edge Position Uncertainty — ±40 ps.

Amplitude — >1 V into 50 Ω.

Variable Range — ±9.9%.

TRIGGER OUTPUT

The oscilloscope under test is normally triggered externally from this source.

Output Amplitude — 1 V minimum into 50 Ω.

Trigger Rate — Marker Mode

Normal — Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers.

Divided by 10 — Reduces normal trigger rate by a factor of ten.

Divided by 100 — Reduces normal trigger rate by a factor of one hundred.

Slewed Edge Mode — One trigger per slewed edge. (Rate divided by 10 and divided by 100 not available).

All Other Modes —

Normal — Slaved to output frequency.

Divided by 10 — One-tenth output frequency.

Divided by 100 — One-hundredth output frequency.

TIMING REFERENCE OUTPUT EXTERNAL TIMING REFERENCE

Input Frequency — Any integral multiple of 1 MHz up to 5 MHz.

Required Accuracy — ±0.001%.

Input Amplitude — 1 V to 10 V RMS.

Input Resistance — 10 kΩ (nominal).

ENVIRONMENTAL

Meets or exceeds MIL-T-28800B, Class 5 requirements.

Temperature —

Operating — 0°C to +50°C.

Non-operating — −20°C to +65°C.

Relative Humidity — 90-95% at +50°C for 5 days.

Altitude —

Operating — 15,000 ft (4.5 km).

Non-operating — 50,000 ft (15 km).

Vibration —

Operating — Displacement (peak-to-peak), 0.015 inch. Vibrating Frequency, 10 Hz - 55 Hz. Total time, 75 minutes.

Shock —

Non-operating — 30 g's, ½ sine, 11 ms duration, 3 shocks in each direction along 3 major axes; total shocks, 18.

Bench Handling —

Operating — 45 degrees or 4 inches or point of balance, whichever occurs first.

MECHANICAL

Maximum Overall Dimensions (triple compartment TM 500 Plug-in).

Height — 4.97 inches (12.63 cm).

Width — 7.96 inches (20.22).

Length — 11.97 inches (30.42 cm).

Net Weight —

Standard Instrument — 8.50 lbs (3.86 kg).

Option 01 — 8.75 lbs (3.98 kg).

PULSE HEAD (Standard Accessory)

The Pulse Head is used to generate fast rise, low distortion pulses for testing higher bandwidth vertical amplifiers.

Amplitude — 1.1 V peak ±5% into 50 Ω.

Adjustable Range — ±10%.

Risetime — ≤200 ps.

Polarity — Positive or negative from ground.

Aberrations — ±3% of pulse amplitude; not to exceed 4% peak-to-peak for adjacent peaks.

Frequency — 100 Hz to 100 kHz (decade steps).

REMOTE VARIABLE HEAD (Optional Accessory)

The Remote Variable Head permits the operator to concentrate on the oscilloscope CRT while remotely operating the following front panel controls: UNITS/DIV control; VARIABLE-FIXED button; CONTINUE pushbutton and the VAR control.

COMPARATOR HEAD (Optional Accessory)

The comparator Head is used to calibrate built-in oscilloscope calibrators against the signals available from the CG 551AP.

Both the oscilloscope calibrator and CG 551AP standard amplitude signals are applied to the Comparator head and simultaneously displayed on the oscilloscope CRT. The CG 551AP signals are then varied to obtain congruent displays. Errors are then displayed on the CG 551AP readout.

Input —

Ac Voltage — ±40 μV to ±100 V.

Signal Frequency — 10 Hz to 1 MHz square wave.

Dc Voltage — +100 mV to +100 V.

Resistance —

Open — Unterminated (the resistance of the oscilloscope input).

50 Ω — 50 Ω ±1% in 50 Ω position.

Maximum voltage is ±5 V peak in the 50 Ω position.

Chop Parameters —

Frequency — 30 Hz nominal. (Auto).

Auto Timeout — Internally selectable. 0.5, 1 or 2 minutes.

INCLUDED ACCESSORIES

Reference Guide.

Output Cable Assembly, 012-0884-00.

Pulse Head.

TM 500 MAINFRAMES

Requires TM 506 MOD JB, RTM 506 MOD JB, or TM 515 MOD UB.

ORDERING INFORMATION

CG 551AP **$12,000**

Option 01 Adds high accuracy time base (TCXO) ..... **Add $500**

Option 02 Deletes Pulse Head ..... **Sub $1100**

TM 506 MOD JB Mainframe **$570**

RTM 506 MOD JB Mainframe **$680**

TM 515 MOD UB Mainframe **$645**

OPTIONAL ACCESSORIES

Comparator Head, Order 015-0310-01 ..... **$500**

Remote Variable, Order 015-0309-01 ..... **$375**

Pulse Head, Order 015-0311-01 ..... **$1400** (when purchased separately)

4052 Graphics Computing Controller (32K bytes memory) (See page 52) **$10,950**

Option 10 Printer Interface ..... **Add $550**

Blank 4052 Tape, Order 119-0680-01 — (box of 5)

119-0680-00 (One each) **$150**

4632 Hard Copy Unit (See page 59).

Option 01 Copy Counter ..... **Add $80**

Paper, Carton of four rolls, Order 006-1603-01 ..... **$20**

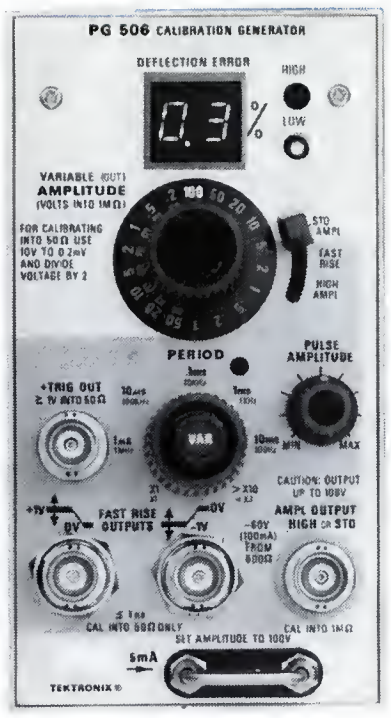
4642 Matrix Printer (See page 60).

Option 01 Rear Feed Tractor Assembly .... **Add $225**

Paper, Carton of 2,500 sheets, Order 002-0262-01 ..... **$33**

GPIB Cable, 2 meter Cable, Order 012-0630-01 ..... **$100**

SCPDA I (ScopeCal Procedure Develop Aid and 465B Verification Program) **$1450**



PG 506

Calibration Generator

PG 506

Three Square-Wave Output Modes

10 Hz to 1 MHz

Direct Readout of Oscilloscope Deflection Error

The PG 506 is a calibration generator for oscilloscopes with three modes of square-wave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. For checking attenuator performance and transient response of oscilloscopes, simultaneous plus and minus low-level, fast rise (1.0 ns) square waves or high amplitude (60 V), extremely clean square waves are available at frequencies from 10 Hz through 1 MHz. A 5 mA calibration current loop is useful for current probe calibration. In the amplitude calibration mode, a 1 kHz square wave is generated whose amplitude may be varied around the calibrated level until the square wave aligns with the oscilloscope vertical graticule divisions; scope deflection error is then read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

AMPLITUDE CALIBRATOR MODE

Period — Fixed at approx 1 ms or dc.

Amplitude — From 100 V p-p to 200 μV p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 5 V p-p to 100 μV p-p into 50 Ω.

Error Readout Range — ±7.5%.

Error Readout Resolution — 0.1%.

PULSE MODES

Period — 1 μs to 10 ms (within 5%) in decade steps with the VARIABLE control in CAL position. VARIABLE extends period to at least 100 ms.

Symmetry — Approx 50% duty cycle.

HIGH AMPLITUDE OUTPUT

Rise Time — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

Amplitude Range — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST RISE OUTPUTS

Rise Time (Terminated into 50 Ω) — 1.0 ns or less.

Amplitude Range (Terminated into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — Within 2% or 10 mV p-p, whichever is greater, during first 10 ns.

Flatness — Within 0.5% after first 10 ns.

Polarity — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

Output Resistance Source — 50 Ω within 3% at + and — output connectors.

Trigger Output (Terminated into 50 Ω) — Positive-going signal of at least 1 V.

Order PG 506 Calibration Generator . $2050

TUNNEL DIODE PULSER

The Tunnel Diode Pulser (067-0681-01) provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 Ω, while rise time is ≤125 ps; aberrations are <1% in a 1 GHz system.

Order 067-0681-01 . . . . . $155

PRECISION VOLTAGE DIVIDER

Designed for use with the PG 506 in the STANDARD AMPLITUDE mode, this 0.4 divider allows your oscilloscope to display a constant 4 divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display 5 divisions of amplitude.

Input Z — 50 Ω with output load ≥100 kΩ.

Max Input — ≤5 V RMS.

Output — 0.4 x PG 506 amplitude.

Voltage Accuracy — ±0.4%.

Order 015-0265-00 . . . . . $115

Oscilloscope Calibration Instruments

TG 501

Time Mark Generator

TG 501

Marker Outputs, 5 s to 1 ns

Direct Readout of Oscilloscope Timing Error

External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from five seconds to one nanosecond. A unique feature on the TG 501 is a variable timing output with a front-panel two digit LED display which indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

Trigger Output Signal — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz
Stability (0° to 50° C) after ½ hour warm-up	within 1 part in 10^5	within 5 parts in 10^7
Long-term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Settability	adjustable to within 1 part in 10^7	adjustable to within 5 parts in 10^9

External Reference Input — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

Timing Error Readout Range — To ±7.5%.

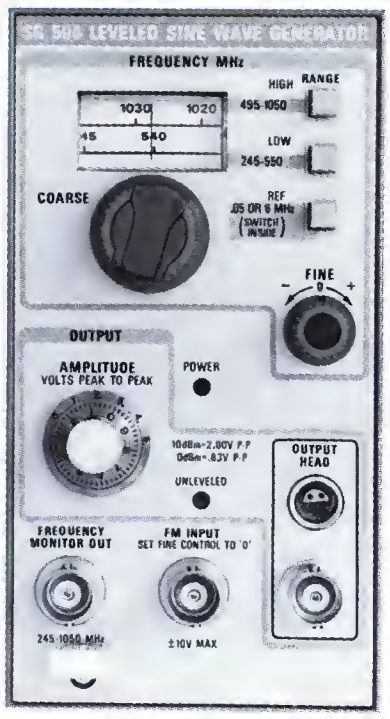
Timing Error Measurement Accuracy — Device under test error is indicated to within one least significant digit (to within one displayed count).

ORDERING INFORMATION

TG 501 Time Mark Generator $1650

Option 01, 5 MHz Time Base . . . . . Add $200

SG 504



Signal Generator

SG 504

Leveled, Variable Output

245 MHz to 1050 MHz

Frequency Modulation Capability

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V peak-to-peak into 50 Ω.

Frequency Range — Low band: 245 MHz to 550 MHz. Highband: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

Frequency Accuracy — ±2% of dial indication.

Amplitude Range — 0.5 V to at least 4.0 V p-p.

Amplitude Accuracy — (at reference) Within 3% of indicated amplitude.

Flatness — ±4% of amplitude at reference frequency.

Harmonic Content — 2nd harmonic at least 25 dB down; 3rd and all higher at least 40 dB down.

Fm Input — Frequency range: dc to 100 kHz. Deviation sensitivity: ±9 V produces from ±0.05% to ±0.4% deviation of carrier, depending on output frequency.

Frequency Monitor Output — ≥0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

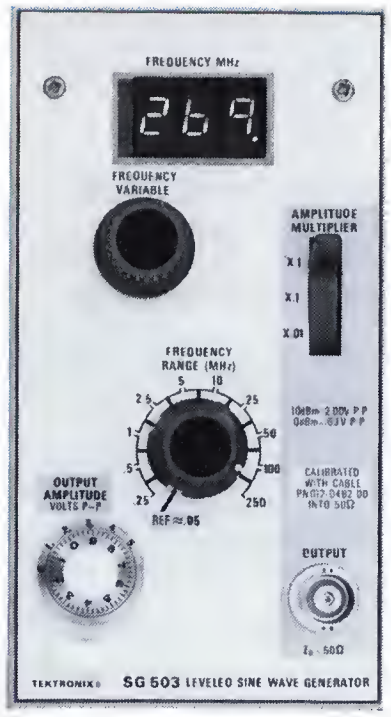
Rear Card Edge Connections — Address fm input, frequency monitor output, and amplitude control.

ORDERING INFORMATION

SG 504 Signal Generator (Includes Leveling Head) $2750

Replacement Leveling Head, (015-0282-00) $375

SG 503



Signal Generator

SG 503

Leveled, Variable Output

250 kHz to 250 MHz

Digital Readout of Frequency

The SG 503 Signal Generator is a general-purpose leveled sine-wave oscillator. It provides a leveled output amplitude which is variable from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage into 50 Ω is variable from 5 mV to 5.5 V peak-to-peak.

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Accuracy — Within ±0.7 of least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

Amplitude Accuracy — (50 kHz reference) Within 3% of indicated amplitude on (X1) range, 4% on (X0.1) range, and 5% on (X0.01) range.

Flatness — (p-p) From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X0.1 and X0.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

Harmonic Content — Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.

Other — Rear edge card connection available to address the leveling circuit.

Standard Accessory — Precision 50 Ω cable 3 ft long. (012-0482-00).

Order SG 503 Signal Generator $1625

SC 504

80 MHz Oscilloscope

SC 504

80 MHz Oscilloscope

5 mV/div Max Sensitivity

5 ns/div Max Calibrated Sweep Rate

Enhanced Automatic Triggering

True X-Y Capability

Switchable Rear Interface Capability

The addition of this plug-in scope makes many new configurations possible, especially for those applications demanding higher bandwidth capabilities. A double-wide plug-in, the SC 504 is compatible with all existing TM 500 Plug-ins and multi-compartment mainframes.

The SC 504 is a general purpose, dual-trace, non-delayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (Ch 1 + Ch 2), differential (Ch 1 − Ch 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable Ch 1, Ch 2 and ext trig inputs). Enhanced auto triggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use. The P6108 and P6062B are the Tektronix Probes recommended for use with the SC 504.

VERTICAL DEFLECTION

Bandwidth at −3 dB points — Dc to at least 80 MHz from 0°C to 35°C; dc to at least 70 MHz from 0°C to 50°C.

Rise Time — 4.4 ns or less from 0°C to 35°C; 5 ns or less from 0°C to 50°C.

Ac Low Frequency Response (lower −3 dB points) — Without probe, 10 Hz; with 10X probe, 1 Hz.

Deflection Factors — Calibrated Range: 5 mV to 10 V/div, 11 steps in a 1-2-5 sequence. Accuracy: 5 mV to 10 V/div (15°C to 35°C) ±2%, (0°C to 50°C) ±3%; in Ch 1-Ch 2 (differential) mode, Channel 2 (15°C to 35°C) ±3%, (0°C to 50°C) ±4%. Uncalibrated Range — Continuously variable between calibrated steps. At least 2.5:1 range. Extends maximum deflection factors to at least 25 V/div.

Modes — Ch 1, Ch 2, Alt., Chop, Ch 1 minus Ch 2, Ch 1 plus Ch 2, X-Y. Chop rate at least 250 kHz.

Input R and C — 1 MΩ ±1% paralleled by approximately 20 pF.

Maximum Input Voltage — Dc coupled: 250 V (dc + peak ac). Ac coupled: 400 V (dc + peak ac). Ac Component: 500 V p-p at 1 kHz or less.

Common-Mode Rejection Ratios — At least 50:1 up to 1 MHz, and 10:1 from 1 MHz to 10 MHz when using the same attenuator settings; common-mode signal 6 divisions or less.

Position Range — ±6 div.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, ±1%, approximately 1 kHz frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 5 ns/div. Uncalibrated (variable) Range — The CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 0.5 s/div.

Sweep Rate Accuracy — Measured over center 8 divisions, excluding first 50 ns and all after the first 10 divisions of magnified sweep.

	15°C to 35°C	
	X1	X10
20 ms/div to 0.2 μs/div	±2%	±3%
0.2 s/div to 50 ms/div	±3%	±4%
0.1 μs/div to 50 ns/div	±3%	±4%

Derate accuracies by an additional 1% from 0°C to 15°C, and 35°C to 50°C.

Trigger Holdoff — CAL (variable) control, if selected by an internal switch, increases trigger holdoff time by a factor of at least 20.

X-Y Mode — Bandwidth: Dc to at least 2 MHz. Deflection Factor, selected by Channel 2 controls and horizontal mag X1, X10 with 5% accuracy. X and Y amplifier phase difference, less than 3° at 50 kHz or less. Input parameters same as Channel 2.

TRIGGER

Trigger Modes — AUTO, NORM, and SGL SWP.

Enhanced Auto Trigger — The trigger circuit automatically adjusts to spread the peak-to-peak signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Sources — Ch 1, Ch 2, LINE, EXT. INT.

Trigger Coupling — Ac, ac Lf REJ, Hf REJ, dc.

Trigger Sensitivity — Minimum Peak to Peak Signal Required.

Coupling	Source	DC to 30 MHz	30 MHz to 80 MHz
Dc	Ch 1, Ch 2 External Interface	0.4 div 60 mV Typ 50 mV	1.0 div 150 mV Typ 100 mV to 50 MHz
Ac	Requirements increase below approx 50 kHz		
Ac Lf REJ	Requirements increase below approx 10 kHz		
Hf REJ	Requirements increase above approx 50 kHz		

External Triggering Level Range — ≥ ± 1.4 V.

External Triggering Input — Input R and C — 1 MΩ ±10% paralleled by approximately 24 pF. Maximum Input Voltage — 250 V (dc + peak ac); 250 V p-p at 1 kHz or less.

AUTO Mode — Sweep free runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approximately the p-p range of the triggering signal.

Single Sweep — Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only.

CRT

Phosphor — P31.

Acceleration Potential — Approximately 12 kV.

Graticule — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

REAR INTERFACE

Ch 1 and Ch 2 Vertical Inputs — Selected by Ch 1 and Ch 2 coupling in INT (interface) position. Input impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 60 pF.

Trigger Input — Selected by TRIGGER SOURCE switch in INT (interface) position. Input impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 40 pF.

Z-Axis Input — Input Impedance: Approximately 1.5 kΩ. +5 V turns beam ON from OFF condition, −5 V turns beam OFF from ON condition.

Channel 1 Output — At least 50 mV/div. Bandwidth: At least 30 MHz. Output Impedance: <50 Ω.

Ramp Output — 0 to +10 V ramp. Output resistance approximately 500 Ω.

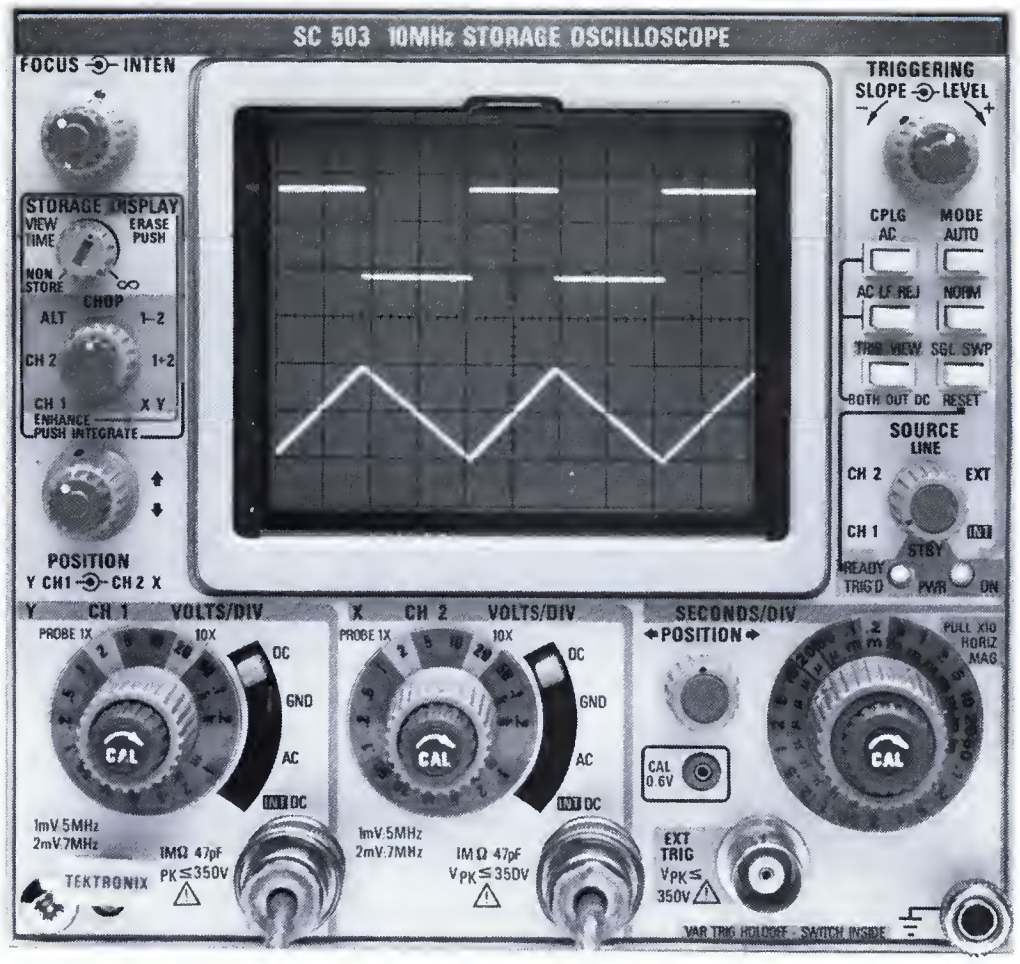
ENVIRONMENTAL CAPABILITIES

Temperature — Operating: 0°C to 45°C (to 50°C in mainframes equipped with fan). Non-operating: −40°C to +75°C.

Altitude — Operating: To 15,000 feet. Non-operating: To 50,000 feet.

Order SC 504 Oscilloscope $2650

Oscilloscope



SC 503

10 MHz Storage Oscilloscope

SC 503

- 10 MHz Bandwidth
- Bistable Storage Auto-erase
- Variable Enhancement and Integration to Increase Writing Speed
- Trigger View
- Variable Holdoff
- Switchable Front/Rear X and Y Inputs
- Rear Z Axis Input
- True X-Y Capability

The SC 503 is a non-delayed sweep, general purpose storage oscilloscope which is compatible with five of our TM 500 Mainframes, (TM 503, TM 504, TM 515, TM 506 and RTM 506).

Because the SC 503 is a storage oscilloscope, it can be used to store and display waveforms after the input signal is removed. This feature is particularly useful when measuring slow repetition rates or single-shot signals, important in the biomedical and mechanical measurements fields. Low frequency signals at heart or respiration rates can be stored for detailed analysis. In the mechanical measurements field the SC 503 can "freeze" fast or transient signals from transducers, which is especially useful in pressure and velocity vs. time analysis and shock testing.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

Major features of the SC 503 include; variable enhancement and integration to increase the writing speed of signals with rapid rise times, an auto erase mode which erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including: acoustic speech testing, nerve potential testing, and optical stimulus response testing. The P6108, P6062B and P6060 are the Tektronix recommended probes for use with the SC 503.

VERTICAL DEFLECTION

Bandwidth at −3 dB points — Dc to at least 10 MHz, (5 mV/div to 20 mV/div); dc to at least 7 MHz (2 mV/div), dc to at least 5 MHz (1 mV/div).

Rise Time — 5 mV to 20 V/div, typically 35 ns or less.

Ac Low-Frequency Response (lower −3 dB points) — Without probe, 10 Hz; with 10X probe, 1 Hz.

Deflection Factors — Calibrated Range: 1 mV/div to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy — 5 mV to 20 V/div (+15°C to +35°C) ±2%, 1 mV/div and 2 mV/div ±5%; (derate accuracy by additional 1% for 0°C to +50°C). Uncalibrated Range: at least 2.5:1 continuously variable between calibrated steps; Extends maximum uncalibrated deflection factor to at least 50 V/div.

Modes — Ch 1, Ch 2, ALT, CHOP, Ch 1 minus Ch 2, Ch 1 plus Ch 2, X-Y.

Input Impedance — 1 MΩ ±1% paralleled by approximately 47 pF.

Maximum Input Voltage — 350 V (dc + peak ac), 700 V peak-to-peak ac at 1 kHz or less. Above 1 kHz recommended peak-to-peak ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.

Common-Mode Rejection Ratio — At least 50:1 at 1 MHz when using same attenuator setting, in Ch 1 minus Ch 2 mode.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, ±1%, approximately 1 kHz frequency.

Position Range — ±6 div.

Channel Isolation — Input isolation: at least 80 dB up to 10 MHz; display at least 50:1 to 10 MHz.

Displayed Noise — Less than 0.2 mV peak to peak at 1 mV/div.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated sweep rates: 2 s to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 50 ns/div. Uncalibrated (variable) Range provides continuously variable sweep rates, between the calibrated rates, and extends the slowest rate of at least 5 s/div.

Sweep Rate Accuracy —	+15°C to +35°C	
	X1	X10
2 s/div to 0.5 s/div	±4%	±5%
0.2 s/div to 5 μs/div	±3%	±4%
2 μs/div to 0.5 μs/div	±4%	±5%

Derate accuracy by an additional 1% from 0°C to 15°C and 35°C to 50°C.

Trigger Holdoff — At least 20:1 range internally selectable.

X-Y Mode — Bandwidth: Dc to at least 500 kHz. Deflection Factor: Selected by Ch 2 controls and Horizontal Mag X1, X10. Phase Difference: Less than 3° at 50 kHz or less.

TRIGGER

Trigger Modes — AUTO (enhanced), NORM, and SGL SWP (single sweep).

Enhanced Auto Trigger — The trigger circuit automatically adjusts to spread the peak to peak signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Sources — Ch 1, Ch 2, LINE, EXT, INT (rear interface).

Trigger Coupling — Dc, ac, ac lf REJ.

Trigger Sensitivity — Minimum Peak to Peak Signal Required.

Source	dc to 5 MHz	5 MHz to 10 MHz
Ch 1, Ch 2	0.4 div	1.0 div
External	60 mV	150 mV
Interface	Typ 35 mV	Typ 80 mV

*With ac coupling requirements increase below approx 50 Hz. With ac Lf REJ coupling requirements increase below approx 10 kHz.

Triggering Level Range — External: At least + and −1.2 V. Internal: At least + and −6.0 divisions.

External Triggering Input — Input Impedance: 1 MΩ, paralleled by approximately 47 pF. Maximum Input Voltage: 350 V (dc + peak ac), 350 V peak-to-peak ac at 1 kHz or less. Above 1 kHz recommended peak-to-peak ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz.

Auto Mode — Sweep free-runs in the absence of a triggering signal. Level control range automatically varies with the triggering signal amplitude for frequencies above 100 Hz.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only.

STORAGE SYSTEM

Stored Writing Speed (center 6 x 8 divisions) — Normal: At least 80 div/ms (50 cm/ms). Enhanced: At least 400 div/ms (250 cm/ms).

Erase Time — 400 ms to 600 ms.

Auto Erase Viewing Time — Continuously variable from ≤0.5 s to ≥5 s.

Maximum Recommended Storage Time — Approximately 4 hours.

CRT

Phosphor — P44

CRT Graticule — 8 x 10 div., 0.25 inch/div (0.64 cm/div). Internal graticule lines.

REAR INTERFACE

Ch 1 and Ch 2 Vertical Inputs — Selected by Ch 1 and Ch 2 coupling in INT (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 100 pF.

Trigger Input — Selected by TRIGGER SOURCE switch in INT (interface) position. Input Impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 60 pF.

Z-Axis Input — Input Impedance: Approximately 1.5 kΩ. +5 V turns beam ON from OFF condition, −5 V turns beam OFF from ON condition.

Ch 1 Output — At least 50 mV/div. Bandwidth: At least 4 MHz. Output impedance: 50 Ω.

Ramp Output — 0 to +10 V ramp. Output impedance approximately 500 Ω.

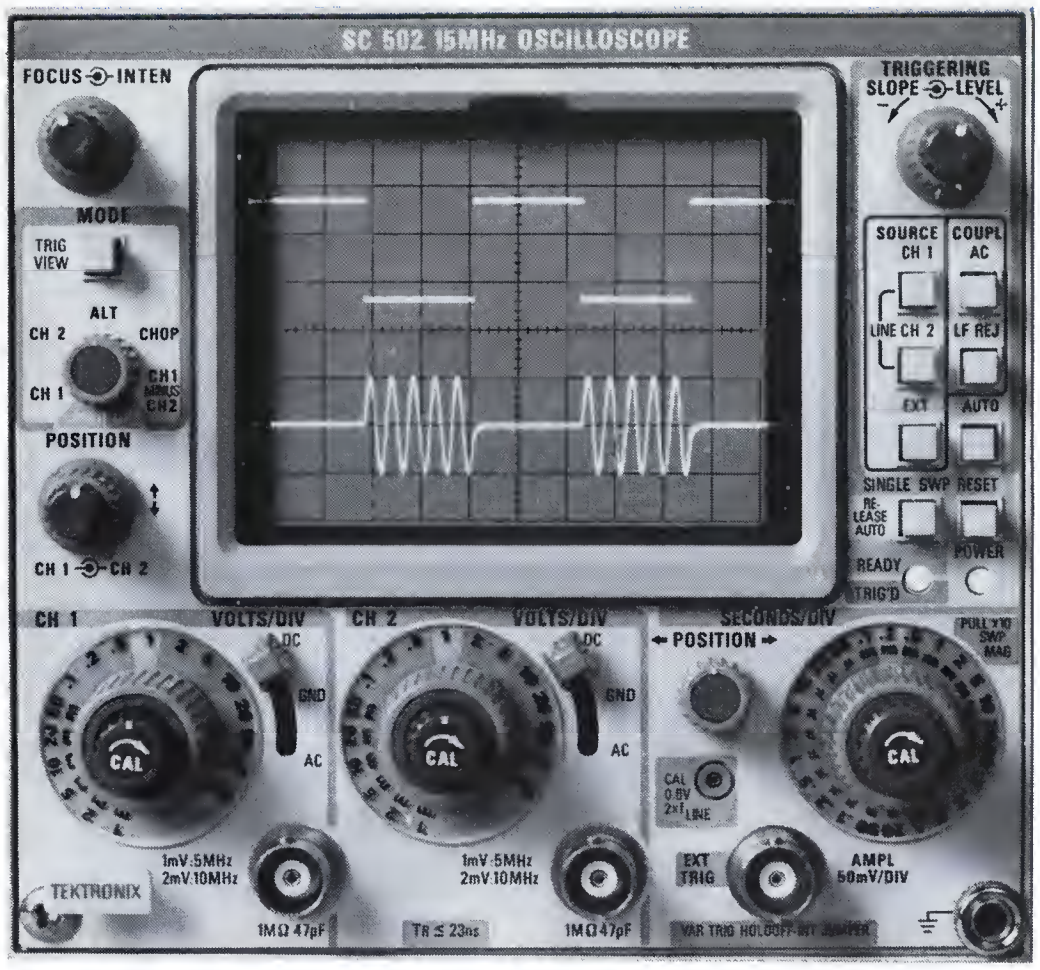
ENVIRONMENTAL CAPABILITIES

Temperature — Operating: 0°C to +45°C (0°C to +50°C in mainframe equipped with a fan). Non-operating: −40°C to +75°C.

Altitude — Operating: To 15,000 feet; maximum operating temperature decreased by 1°C/1000 feet from 5000 feet to 15,000 feet. Non-operating: To 50,000 feet.

Order SC 503 10 MHz Storage Oscilloscope $2850

Oscilloscope



SC 502

15 MHz Dual-Trace Oscilloscope

SC 502

- 15 MHz Bandwidth
- Dual-Trace
- 20 ns/div Max Calibrated Sweep Rate
- 1 mV/div Max Sensitivity
- Delay Line
- Trigger View
- Variable Trigger Hold-off
- Enhanced Automatic Triggering

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope designed to operate in any two adjacent compartments of TM 500 Power Module/Mainframes. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.

As with many Tektronix Products, the SC 502 features circuits, sub-circuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disc memories, key-to-tape, printers, plotters, punches, readers, and terminals. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well-proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.

The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interfacing capability of the SC 502 and all TM 500 Instrumentation suggests exceptional applicability to systems of built-in test equipment or rack-mounted installations. And the TM 515 Traveler Mainframe with the SC 502 form a nucleus for sophisticated, compact field service "packages."

Tektronix Probes P6062B and P6108 are recommended for use with the SC 502.

VERTICAL DEFLECTION

Bandwidth at −3 dB points — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

Rise Time — 5 mV to 20 V/div, 23 ns or less.

Ac Low-Frequency Response (Lower −3 dB points) — Without probe, 10 Hz; with probe (10X), 1 Hz.

Deflection Factors — Calibrated range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0° to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (variable) range. At least 2.5:1 range. Continuously variable between calibrated steps. Extends max attenuator step to at least 50 V/div.

Modes — Ch 1, Ch 2, ALT, CHOP, Ch 1 MINUS Ch 2. Chop rate at least 250 kHz.

Input Impedance — 1 MΩ within 1% paralleled by approx 47 pF.

Max Input Voltage — 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

Common-Mode Rejection Ratio (Ch 1 minus Ch 2 mode) — At least 50:1 at 1 MHz when using same attenuator setting.

Channel Isolation — Input isolation: at least 80 dB up to 15 MHz; display related: at least 50:1 up to 15 MHz.

Displayed Noise — 200 μV or less of noise tangentially measured.

Position Range — ±6 div.

Calibrator — Voltage, 0.6 V ±1%. Frequency, twice the power line frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (variable) Range: the CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

Sweep Rate Accuracy — Within 3% unmagnified and within 5% magnified.

Trigger Holdoff — CAL (variable) control, if selected by an internal jumper, increases trigger holdoff time by a factor of at least 20.

External Horizontal Amplifier — Bandwidth: dc coupled, dc to at least 2 MHz; ac coupled less than 50 Hz to at least 2 MHz. Deflection Factor, 50 mV/div within 5%. X and Y Amplifier Phase Difference, less than 3° at 50 kHz or less. Input Impedance, 1 MΩ within 2% paralleled by approx 47 pF. Max Input Voltage: 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

TRIGGER

Enhanced Automatic Triggering — In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Modes — AUTO (enhanced), NORMAL (auto button out), SINGL SWP.

Trigger Sources — Ch 1, Ch 2, LINE EXT.

Trigger Coupling — Dc, ac, ac lf REJ.

Trigger Sensitivity — Minimum Peak to Peak Signal Required.

Source	dc to 5 MHz	5 MHz to 15 MHz
Ch, Ch 2	0.4 div	1.0 div
External	60 mV	150 mV

With ac coupling requirements increase below approx. 50 Hz. Ac Lf REJ coupling requirements increase below approx 5 kHz.

Triggering Level Range — Internal: at least ±8 div. External: at least ±1.2 V.

External Triggering Input — Input Impedance: 1 MΩ within 2% paralleled by approx 47 pF. Max Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

Auto Mode — Sweep free-runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approx the p-p range of the triggering signal.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. AUTO pushbutton must be in the OUT position for operation and for setting triggering controls.

CRT

Phosphor — P31.

Deflection — Electrostatic.

Acceleration Potential — Approximately 12 kV.

Graticule — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

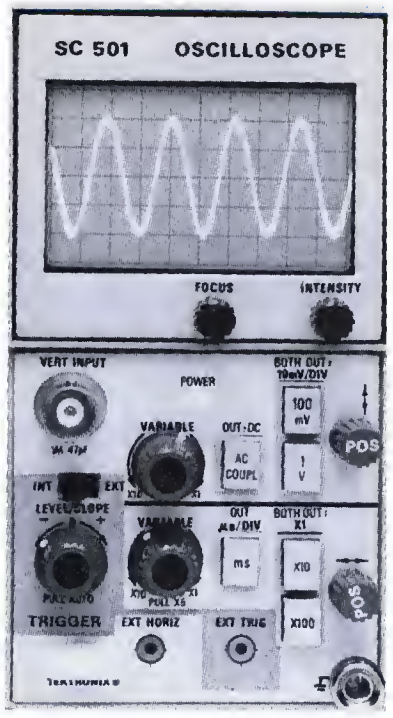
ENVIRONMENTAL CAPABILITIES

Temperature — Operating, 0°C to +50°C. Non-operating −40°C to +75°C.

Altitude — Operating, to 15,000 ft. Non-operating to 50,000 ft.

Order SC 502 15 MHz Oscilloscope . . $1950

Oscilloscopes



SC 501

Oscilloscope

SC 501

5 MHz Bandwidth

Single Compartment Size

6.4 cm (2½ inches) CRT

Versatile Operating Features

The SC 501 is a single-channel 5 MHz plug-in unit oscilloscope with a 2.5 inch crt display which occupies a single TM 500 Series Plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500 Series Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500 Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 Mainframe, it can be used on the bench, in a rack, or on the road. The single-channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by pushbutton logic in decade steps from 1 μs/div to 100 μs/div (microsecond), and from 1 ms/div to 100 ms/div (millisecond range). A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions such as sweeping a voltage-controlled frequency oscillator or obtaining variably delayed pulses from the PG 505 Pulse Generator.

The triggering circuits allow stable triggering from either internal or external sources. An AUTO triggering mode and manual LEVEL/SLOPE selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

An internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

VERTICAL DEFLECTION

Bandwidth — Dc to >5 MHz.

Deflection Factors — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

Input Coupling — Ac or dc.

Input Impedance — 1 MΩ paralleled by 47 pF.

Max Input Voltage — 350 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — Calibrated sweep rates: 1 μs/div to 100 ms/div in decade steps. Uncalibrated (variable) range: extends slowest calibrated rate to ≥1 s/div. X5 magnifier (fixed): extends fastest calibrated sweep rate to 200 ns/div. Accuracy (over center 8 div): ≥5% for all sweep rates. Linearity (any two div portion within center eight div): ≥5%.

External Horizontal Amplifier — Bandwidth: dc to 100 kHz. Input impedance: ≥100 kΩ paralleled by 25 pF. Max input voltage: ±3 V.

TRIGGER

Normal Trigger Sensitivity (Trigger Level/Slope In) — Internal: dc coupled, 0.4 major div of deflection at dc; increasing to 1.0 major div of deflection at 5 MHz. External: dc coupled, 1 V minimum to 5 V max from dc to 5 MHz. External trigger input impedance: 22 kΩ paralleled by approx 150 pF.

Auto (Trigger Level/Slope Out) — Sweep free-runs in absence of trigger signal, or for trigger repetition rates below 10 Hz.

CRT

Phosphor — P31.

Graticule — 6 X 10 div (0.203 in per div).

Order SC 501 5 MHz Oscilloscope $950

OSCILLOSCOPES COMPARISON CHART

	SC 504	SC 503	SC 502	SC 501
Crt	8 x 10 div, 0.25 in/div P31 Phosphor	8 x 10 div, 0.25 in/div, Bistable Storage, P44 Phosphor	8 x 10 div, 0.25 in/div P31 Phosphor	6 x 10 div, 0.203 in/div P31 Phosphor
Vertical (Y) axis	Dual-trace. 80 MHz, 5 mV/div to 10 V/div, Alt, CHOP, Ch 1 minus Ch 2, Ch 1 + Ch 2, X-Y modes	Dual-trace, 10 MHz, 1 mV/div to 20 V/div, Alt, CHOP, Ch 1 minus Ch 2, Ch 1 + Ch 2, X-Y modes	Dual-trace, 15 MHz, 1 mV/ per div to 20 V/div (5 and 10 MHz bandwidth at 1 and 2 mV) ALT, CHOP, and Ch 1 minus Ch 2 modes	5 MHz bandwidth, 10 mV/ div to 10 V/div
Horizontal (X) axis	Triggered sweep 50 ns/div to 0.2 s/div with X10 magnifier. Enhanced auto trig, line ext/int trig, single sweep, external horizontal input, variable trigger holdoff	Triggered sweep 50 ns/div to 2 sec/div with X10 magnifier. Enhanced auto trig, line, ext/int trig, single sweep, external horizontal input, variable trigger holdoff	Triggered sweep 200 ns/div to 0.5 s/div with X10 magnifier, enhanced auto, trigger, line, ext/int trig. single sweep, external horizontal input, variable trigger holdoff	Triggered sweep 1 μs/div to 1 s/div with X5 magnifier to 200 ns/div, normal/auto trigger, internal/external-trigger, external horizontal input
Other features	Trigger view, switchable rear interface capability	Bistable storage, auto erase, variable enhancement and integration, rear interface capability, trigger view	Trigger view	Compact display
Price	**$2650**	**$2850**	**$1950**	**$950**

Digital Latch, Digital Delay, Word Recognizer

DD 501

Digital Delay

DD 501

Digital Events Delay

Delay to 99,999 Events

Divide by N up to 20 MHz

Pulse Counting to 65 MHz

Time Delay with Ext Clock

Compatible with Most Attenuator Probes

The DD 501 is an events count or count down plug-in unit. The unit counts a predetermined number of events, from 0 to 99,999, selected by the front-panel thumb-wheel switches. The DD 501 can also function as a frequency divider, or it can be used in a "counted burst' mode with pulse or function generators that can be synchronously gated. Tektronix generators capable of being gated by the DD 501 are the FG 501, FG 502, FG 504, and the PG 508.

EVENTS DELAY

Count — 1 to 99,999 events.
Max Count Rate — 65 MHz.
Insertion Delay — 30 ns or less from final event to trigger output pulse.
Recycle Time — 50 ns or less.
Reset — Manually resets delay counter.

INPUT CHARACTERISTICS

(All characteristics apply to both events and start inputs).
Input Impedance — 1 MΩ, 20 pF.
Slope — Either + or −, selectable.
Sensitivity — 85 mV p-p @ 30 MHz.
Frequency Response — Up to 65 MHz at 120 mV sensitivity.
Minimum Detectable Pulse Width — 5 ns.
Threshold Level Range — From −1.5 V to +1.5 V (−15 V to +15 V with 10X probe). Can be externally programmed or monitored at front panel jacks.
Trigger View Out — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).
Events Triggered Light — Visual indication that events are being detected.
Start Triggered Light — Visual indication that delay is in progress.

TRIGGER OUTPUT

Pulse Width — Width of events pulse plus 6 ns or less.
Voltage Swing — + 0.8 V or less to at least + 2.0 V with 3 TTL loads (≃5 mA).
Light — Indicates output trigger.

GENERAL

Temperature — Operating: 0°C to +50°C. Non-operating: −40°C to +75°C.
Altitude — Operating: to 15,000 ft; Non-operating: to 50,000 ft.

Order DD 501 Digital Delay $1075

DL 502

Digital Latch

DL 502

16 Channel Latching Capability

Captures Glitches as Narrow as 5 ns at Probe Tips

Allows Expansion of Information Time Frame

TM 500 Compatibility

The TEKTRONIX DL 502 Digital Latch extends the logic analyzer's measurement capabilities. The Digital Latch aids in detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. The 16 channel latch captures asynchronous glitches of less than one sample interval or as narrow as 5 ns.

In asynchronous measurements without latching capability, high speed data anomalies go undetected if they do not appear on a clock edge. The DL 502 Digital Latch captures the glitch and holds it until the next clock edge, then expands and displays it for one sample interval.

SPECIFICATIONS

Minimum pulse width to initiate latch — 5 ns.

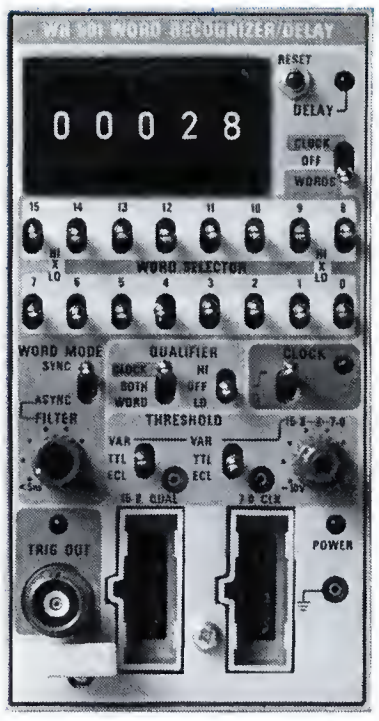
Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock — 50 ns.

Order DL 502 Digital Latch $1480

Standard accessories include instruction manual, 6 inch BNC cable.

WR 501



Word Recognizer with Digital Delay

WR 501

The WR 501 is a 16 bit parallel Word Recognizer with digital delay that produces trigger pulses when a preselected word occurs. It occupies one plug-in position in any TM 500 Series Power Module Mainframe.

The WR 501 may also be used separately as a word recognizer to generate triggers for oscilloscopes or other measurement instruments. It gives you fast access to any unique word in the data stream.

WORD RECOGNIZER (WR 501)

Inputs — 16 data inputs plus a clock and qualifier.

Word Selection — Made using sixteen three-position toggle switches. Positions are HI, (don't care), and LO.

Qualifier — Can expand the word recognizer to 17 bits, act as a gate for the external clock or do both.

Clock — Selects positive- or negative-going edge of clock input signal. Used for synchronous operation.

Modes — Front panel selection of snychronous word recognition (a trigger is produced only when the operator selected word occurs at a clock edge; either position, positive or negative edge, may be selected), or asynchronous word recognition (a trigger is produced anytime the recognized word occurs).

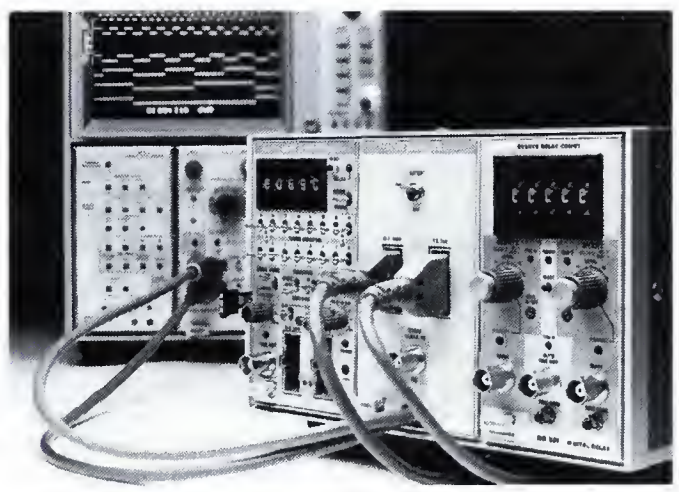
Synchronous Mode —

Minimum Set-up time	18 ns
Minimum Hold time	0 ns

(Filter is automatically disabled)

Asynchronous Mode and Filter —
Minimum coincidence time is variable from 15 ns or less to 200 ns or more.

Order WR 501 Word Recognizer $1850



The DL 502 Digital Latch and WR 501 Word Recognizer are TM 500 Plug-Ins compatible with all Tektronix Logic Analyzers (page 39-40).

Mainframes

TM 500 Plug-ins slide into any one of several power-module mainframes. They are available in six versions accepting one instrument, or combinations up to six. Below are described each of the six mainframes built by Tektronix for TM 500 Instrumentation.

Option 02 Rear Interface for interconnection of instruments at mainframe rear interface. (Option 05 with TM 515).

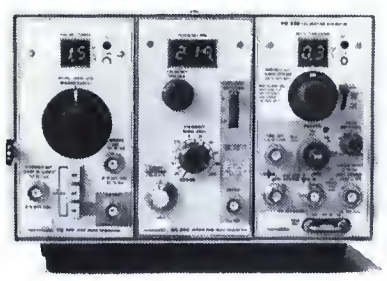
Option 07 — For operating TR 503 and DC 508A Option 07 in a TM 503, TM 504, TM 506, or TM 515.

TM 501

Built for use with one single wide plug-in module.

ORDERING INFORMATION

TM 501 ..... **$270**
TM 501 Option 02 Interface ..... **Add $55**

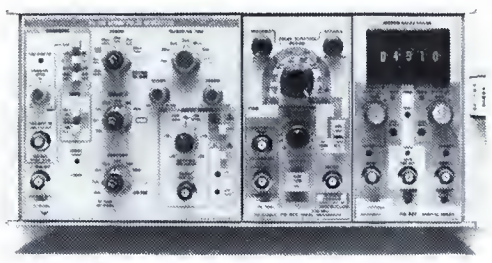


TM 503

Accepts up to three single wide TM 500 Plug-ins. This lightweight, portable, benchtop mainframe includes a front panel power switch and tilt bail. Also fits easily into the shelf of a TEK Model 3 Lab Cart. A carrying case is available to protect the mainframe during transportation.

ORDERING INFORMATION

TM 503 ..... **$270**
TM 503 Option 02 Interface ..... **Add $75**
TM 503 Option 07 Interface ..... **Add $25**



TM 504

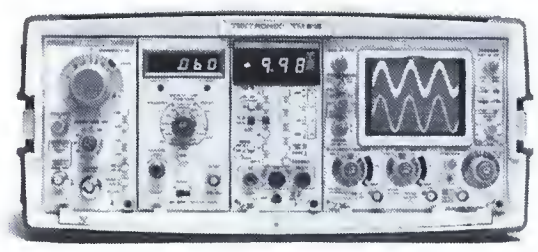
The TM 504 can be fitted with up to four different TM 500 Plug-ins. This mainframe is designed to fit into the shelves of the TEK Model 3 Lab Cart for complete test station mobility. Each TM 504 Mainframe also comes equipped with front panel switch, tilt bail and a handle. An optional carrying case is available for transportation to and from the worksite.

ORDERING INFORMATION

TM 504 ..... **$300**
TM 504 Option 02 Interface ..... **Add $100**
TM 504 Option 07 Interface ..... **Add $25**

MAINFRAMES DIMENSIONS & WEIGHTS
(without Plug-ins)
CABINET

	TM 501		TM 503		TM 504		TM 506		RTM 506		TM 515	
Dimensions	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
Height	6.0	15.2	6.0	15.2	6.0	15.2	6.0	15.2	5.25	13.3	6.8	17.3
Width	3.9	9.9	8.7	22.1	11.0	27.9	17.4	44.2	19.0	48.3	15.0	38.1
Length	15.3	38.9	15.3	38.9	20.0	50.8	20.0	50.8	18.9	48.0	20.0	50.8
Weight (approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	5.4	2.4	11.5	5.2	20.5	9.3	29.0	13.2	32.0	14.4	22.5	10.2
Domestic Shipping	13.0	5.9	17	7.7	26.0	11.8	41.0	18.6	46.0	21.0	30.0	13.6

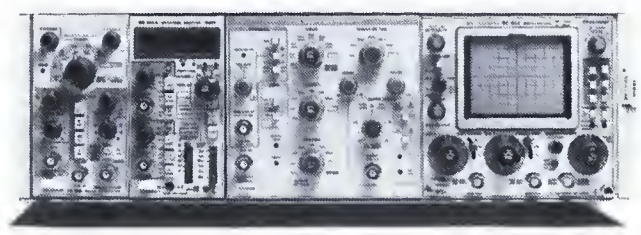


TM 515

The TM 515 Traveler Mainframe is designed to protect up to 5 separate instruments during transportation to and from the worksite. Included with this rugged mainframe are pop-off front and back covers which protect the instruments and also store accessories. The Traveler Mainframe will slide easily under an airline seat when traveling and comes equipped with a heavy duty handle and tilt bail.

ORDERING INFORMATION

TM 515 ..... **$470**
TM 515 Option 05 Interface ..... **Add $75**
with Option 06 48-440 Hz fan ..... **Add $150**
TM 515 Option 07 Interface ..... **Add $25**

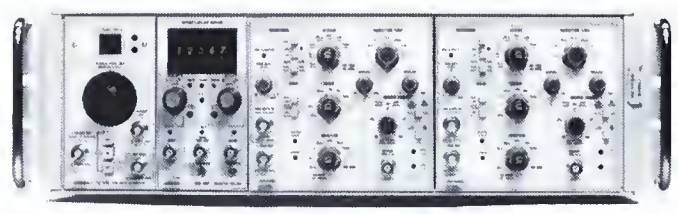


TM 506

This mainframe can power up 6 different plug-in's, providing a complete test station with one power cord. Like most TM 500 Mainframes, the TM 506 is available with the Option 02 which allows rear-interfacing of different modules, reducing front panel clutter.

ORDERING INFORMATION

TM 506 ..... **$420**
TM 506 Option 02 Interface ..... **Add $150**
TM 506 Option 07 Interface ..... **Add $25**



RTM 506

The RTM 506 is a rackmount version of the TM 506. It contains all the same features with the added front panel handles and rackmount rails for built-in configurable test stations. This mainframe saves you space and money in tight situations.

ORDERING INFORMATION

RTM 506 ..... **$530**
RTM 506 Option 02 Interface ..... **Add $150**

POWER REQUIREMENTS

Line Voltage Ranges — International Transformer: 100, 110, 120, 200, 220, 240 V ac, all within 10%; but not to exceed 250 V ac. Range changing for transformer accomplished with quick-change line-selector block.

Line Frequency Ranges — International Transformer: 48 Hz to 440 Hz.

NOTE: The ventilating fans on the TM 506 and TM 515 operate on 48-60 Hz only.

Power Consumption — Max primary power approx: 35 W for TM 501, 120 W for TM 503, 200 W for TM 504, 320 W for TM 506, and 240 W for TM 515. Actual power consumption depends on plug-in selection and operating modes.

SUPPLIES (UNREGULATED)

Shared by All Compartments — +33.5 V dc and −33.5 V dc. TM 501: 500 mA max. TM 503: 1 A max. TM 504: 1.4 A max. TM 506: 2.1 A max. TM 515: 1.8 A max.

Low Power Compartments — Two 25 V ac windings, 500 mA each, supplied to each compartment, independently. 17.5 V ac and +11.5 V dc shared in any combination between these two supplies and among all low-power compartments. TM 501: 1 A max. TM 503 and TM 504: 3.6 A max. TM 506: 6.5 A max. TM 515: 6.5 A max.

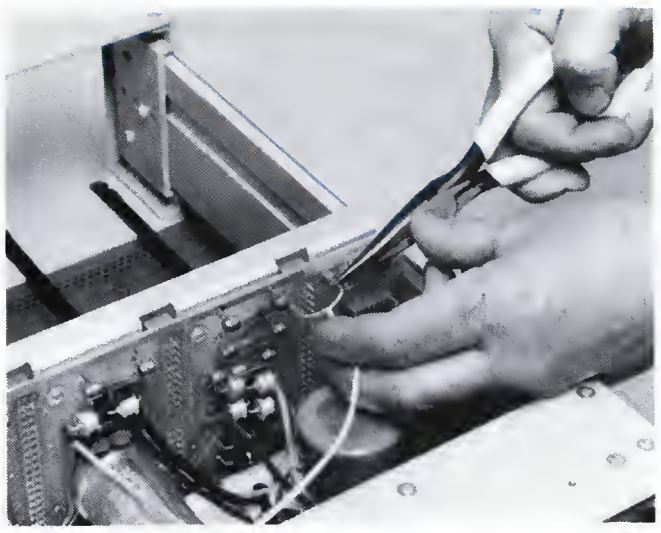
High Power Compartments — (nearest to switch in TM 504 and TM 506): Two 25 V ac windings, 1 A each. 17.5 V ac and +11.5 V dc, 4 A max, shared in any combination between these two supplies.

TEMPERATURE RANGE

Operating — 0°C to +50°C.
Non-operating — −40°C to +75°C.

ALTITUDE RANGE

Operating — To 15,000 ft.
Non-operating — To 50,000 ft.



REAR INTERFACE CAPABILITY WITH TM 500

TM 500 Mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage set-ups without any need to move test leads. Any module can be internally connected thru the mainframe and can also be externally interfaced out the back panel.

Most TM 500 Plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines which are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel 50-pin male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

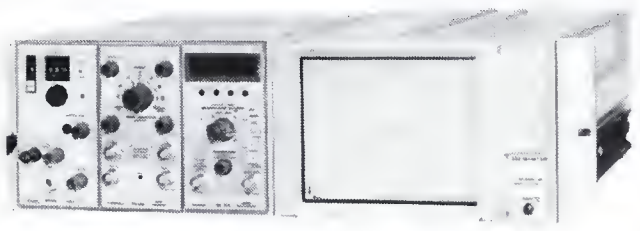
The TM 515 Mainframe is available with an Option 05 interface which includes everything in the Option 02 except for the rear panel 50-pin male connector, mating cable connector and the BNC connectors.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 500 Mainframe except the TM 501. The kit includes fourteen square pins, and 3 coaxial cables, all with female pin receptacles. Installation instructions also included.

For "do-it-yourself" modification kit
Order 040-0846-01 .....**$35**

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

CABINET-TO-RACKMOUNT CONVERSION KITS AND MONITORS



Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two TM 503s side-by-side in a standard rack width.
Order 040-0616-02 .....**$110**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.
Order 040-0617-02 .....**$150**

Rackmount-to-cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.
Order 040-0618-01 .....**$55**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 and a 603, 603A, 604, 604A, 605, 606, 606A, 607, 607A, 608 or 624 in a standard rack width.
Order 040-0624-01 .....**$90**

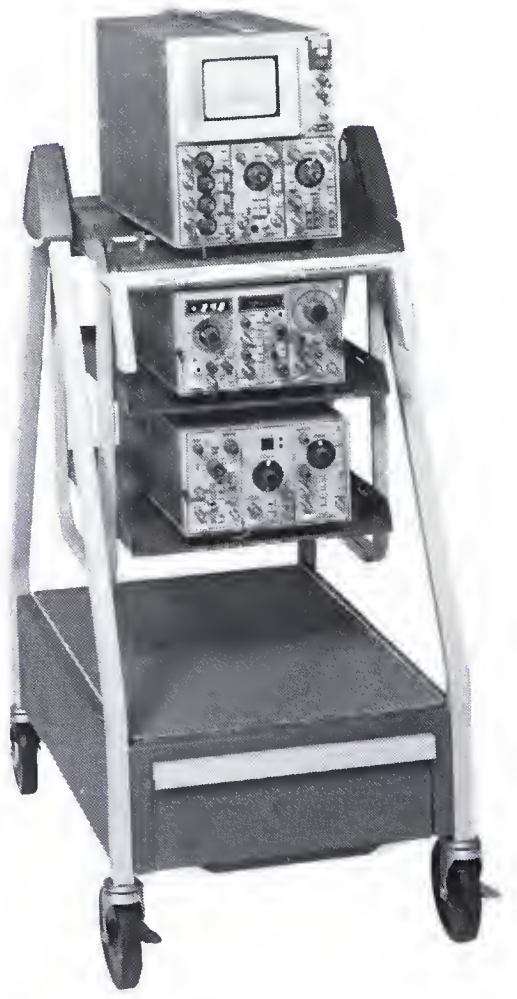
Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to convert a TM 506 (cabinet style) to an RTM 506.
Order 040-0761-03 .....**$125**

Rackmount-to-cabinet conversion kit equipped to convert an RTM 506 to cabinet style TM 506.
Order 040-0762-00 .....**$60**

MONITOR ORDERING INFORMATION

A broad range of display monitors may be rackmounted. These include two storage monitors, the 603A Bistable Monitor, and the 607A Variable Persistence Monitor. Non-storage monitors include the 604A (low cost), 606A (high resolution), the 608 (high brightness) and the 624 (good performance —low cost). See page 63 for more information.

TEK LAB CART MODEL 3



This Lab Cart is especially designed for roll-about configurations combining TM 500 instrumentation with the TEKTRONIX Oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray accepts any TEKTRONIX 7000 Series, 5000 Series, or Portable Oscilloscope. The MODEL 3 comes standard with one lower shelf that will support either a TM 503 or TM 504 with plug-ins. Additional shelves are available as optional accessories. Max capacity of the lower shelf area is two TM 503s or TM 504s, stacked, or up to a TEKTRONIX 7000 Series Oscilloscope in size—with TM 500 packages placed on the tray at your option. The power distribution module at rear underside of the top tray provides four power outlets and a 15 foot line cord.

International modification (Option 01) deletes power distribution module.

TEK Lab Cart Model 3 .....**$425**

with Option 01 (International Modification) .....**No Charge**

Additional Lower Shelf,
Order 436-0132-01 .....**$32**

Safety Belt to secure oscilloscopes or TM 500 to top tray or lower shelves (not needed for 5000 or 7000 Series on top tray).
Order 346-0136-01 .....**$21**

Accessories

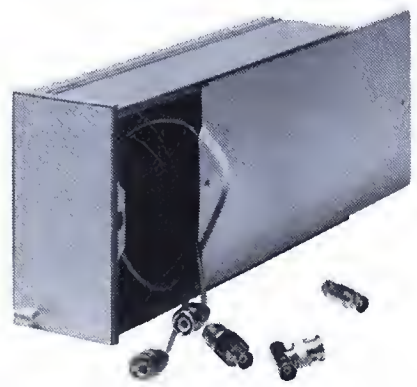
TM 500 Application and Construction Notes

The TM 500 product line is supported by an on-going program to keep you informed of how to achieve optimal performance and versatility from your TM 500 instruments. Tektronix' goal of providing you with solutions to difficult measurement problems does not end with your purchase of TM 500 Instruments.

Application Notes take you through the steps necessary to solve complex problems, or to make more useful measurements with your TM 500 instruments. Subjects include integration through v to f conversion, generating delayed pulses, and current sinking with power supply modules.

Construction Notes provide information necessary to build custom circuits using a TM 500 Blank Plug-in Kit and standard components. These notes are developed from the actual construction of more common special circuits; they include parts lists, schematics and other construction details. Some of the available notes include: power supply circuits, thermal true rms converter, and analog multipliers.

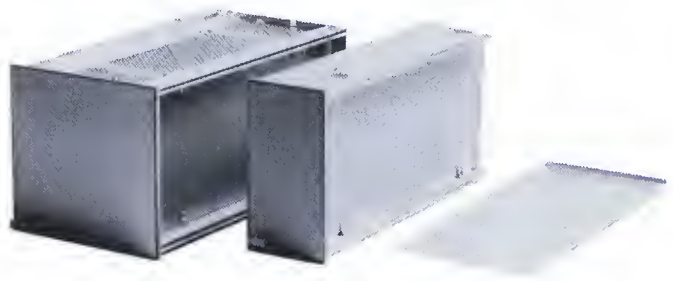
PLUG-IN STORAGE COMPARTMENT



An electronic engineer or technician away from his bench seldom has enough storage space for probes, cables, "tees", accessories, and small tools. The plug-in storage compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler Mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 Mainframes, 5000 Series Oscilloscope Mainframes, and 203 and 204 SCOPE-MOBILE® Cart plug-in storage bins; inside dimensions 25 cm L x 5.1 cm W x 10.6 cm H, (9⅞ in L x 2 in W x 4¼ in H).

Order 016-0362-01 . . . . . $95

TM 500 CUSTOM PLUG-IN KITS



Single and double compartment sizes

A complete test and measurement set-up for many typical jobs requires at least one non-standard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceed the cost of the functional elements.

This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards which allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator ICs can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 Instrumentation.

Single Compartment with Power Supply

Now a blank plug-in kit complete with power supply parts and circuit board layout is available. A single-wide compartment, this plug-in kit saves set up time and build time as the power supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

(1) A ground-referenced positive supply, capable of +7 V to +20 V at up to 400 mA. (Adjustment is centered at 15V; change of resistor values required for total 7-20 V range).

(2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.

(3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 Construction Notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested power supply circuits, thermal true RMS converter

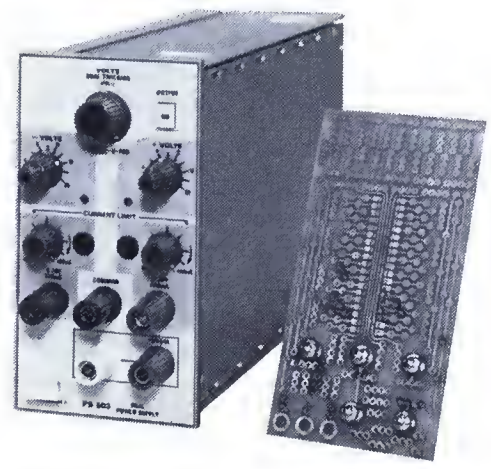
Custom Plug-in Kit with Power Supply (single compartment) 040-0803-02 . . . . . $90
Custom Plug-in Kit (single compartment) 040-0652-05 . . . . . $75
Custom Plug-in Kit (double compartment) 040-0754-07 . . . . . $100

TM 500 BLANK PANEL

When operating the TM 500 Instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

Blank Plug-in Panel, Order 016-0195-03 . . . . . $21

FRONT-PANEL CIRCUIT BOARD ADAPTER KIT PS 501-1 or PS 503A



The front-panel circuit-board kit is a convenient way to mount small experimental circuits or fixtures right on the front of a TM 500 Power Supply.

Typical applications for the adapter are as a device tester (test fixture), educational demonstrator (especially ICs), and in temporary systems functions, e.g., OR'ing and AND'ing two signals. This adapter will supplement the blank plug-in kit for simple or temporary applications.

The adapter kit provides a convenient platform for building up circuits; its pin holes are pre-solder-flowed and some are interconnected. Discrete devices can be readily attached to the adapter kit board, stored, and easily reattached to the "banana jack" plugs on the face of the power supply. Circuit clips for interconnected pin holes are available from Tektronix. The adapter kit is 2.5 inches wide.

Order 013-0152-00 . . . . . $22

Accessories

AM 501 AUXILIARY CIRCUIT BOARD KIT

The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is approximately 2.5 inches square. The kit is a pc board which has six terminal studs for attachment to the amplifier's banana jacks. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier.

An additional advantage of the kit is that it does not interfere with the other connectors on the face of the AM 501.

Order 013-0146-00 .....$22

Type 1105 Battery Power Supply

TM 500 Instruments may be operated with the Type 1105 when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full power module in a typical situation.

TM 501	5.0 hours
TM 503	1.6 hours
TM 504	1.3 hours
TM 506	0.9 hour
TM 515	1 hour

ORDERING INFORMATION

1105 Battery Pack $1100

Option 01, 230 V operation .....No Charge

MANUAL (ONE SHOT) TRIGGER GENERATOR RG 501, PG 501, and PG 505

The Manual (one shot) Trigger Generator is a self-contained, battery-operated, hand-held device for manually generating a single pulse. This adapter is used to start a pulse, ramp, sweep, or complete sequence of events on instruments which do not have a manual trigger button or where a remote operation capability is desired, such as some oscilloscopes and the PG 501, PG 505, and RG 501.

The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally two milliseconds in width and three volts in amplitude with a rapid rise and fall. Output impedance is low (50 Ω); the pulse amplitude drops from about 3.6 to 1.8 volts when changed from a high impedance to a 50 Ω termination. Both voltages decrease with battery aging. The battery is a 5.4 V dry cell.

Applications for the trigger generator also include stepping or sequencing of digital systems, analog control systems, mechanical devices, as well as obtaining "single shot" operation from many types and brands of instruments. Biological and physical experiments, where manual triggering is required as a part of the stimuli, are also common applications.

Order 016-0597-00 .....$125

RAIN COVERS

These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 packages of instrumentation, and include adequate space for protective front covers, as well. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

ORDERING INFORMATION

TM 504 Rain Cover
016-0621-00 .....$45

TM 503 Rain Cover
016-0620-00 .....$35

PROTECTIVE FRONT COVER

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 Mainframes. The cover adds 4.5 cm (1.75 inches) to the length of the TM 503, TM 504, and TM 506 Mainframes, and clears the longest knob projections on any of the instruments.

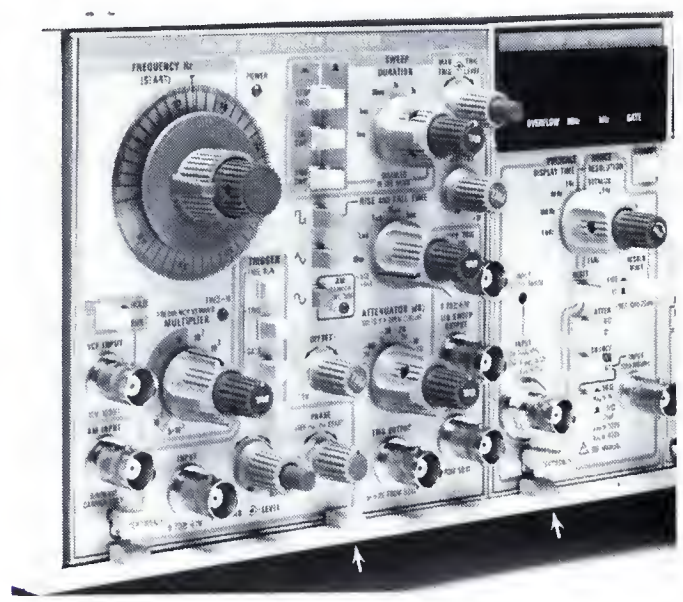
ORDERING INFORMATION

TM 503 Front Panel Cover,
200-1566-00 .....$14

TM 504 Front Panel Cover,
200-1727-00 .....$15

TM 506 Front Panel Cover,
200-1728-00 .....$18

MAINFRAME RETAINER BAR



The mainframe retainer bar modification kit comes complete with the retainer bar, all necessary parts and instructions.

You may modify the TM 504 or RTM 506/ TM 506 Mainframe: each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit. Then, the retainer bar can be simply added or removed with four screws, accessible from the bottom of the mainframe.

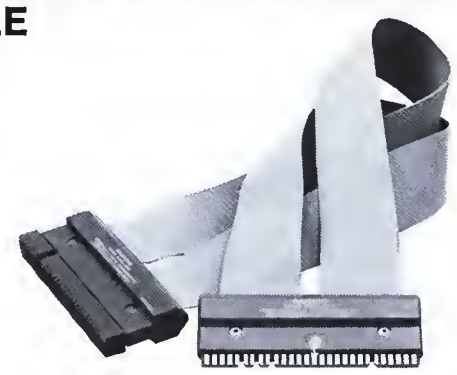
ORDERING INFORMATION

TM 504—020-0548-00 .....$45.00

TM 506 and RTM 506—020-0549-00 ..$50.00

Accessories

TM 500 FLEXIBLE EXTENDER CABLE



Designed to couple a TM 500 Plug-in with the mainframe rear interface board connection. It provides a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

Extender Cable, Order 067-0645-02 . . . $110

RISE TIME LIMITER

For use with the PG 502 Pulse Generator which has a pulse rise and fall time of less than one nanosecond. In some applications, such as TTL logic where slower rise time is needed, this fast pulse can be limited to six nanoseconds by using the rise time limiter.

Rise Time Limiter, Order 015-0249-00 . . $85

P6420 Rf PROBE

Voltage Range — 5 V to 25 V RMS (70.7 V p-p). **Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS ±10% (15° to 35°C). 5.0 V to 25 V rms ±5% (15°C to 35°C). **Frequency Response** — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB). **Input Capacitance** — ≃ 3.7 pF. **Maximum Input Voltage** — 42.4 V (peak ac + dc). **Temperature Range** — Nonoperating; −55°C to +75°C. Operating; +15° to +35°C. **Length** — Probe only 9.6 cm. Cable only 2 meters.

INCLUDED ACCESSORIES

013-0097-01	1 **TIP,** probe, retractable (BO)
344-0040-00	2 **CLIP,** alligator (AU)
175-0849-00	1 **LEAD,** ground, 3 in (7.5 cm) (BC)
175-1017-00	1 **LEAD,** ground, 6 in (13 cm) (BE)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
352-0351-00	1 **HOLDER,** probe
103-0090-00	1 **ADAPTER,** BNC female to dual banana (BN)
	2 **TIP,** probe replaceable*

*Available in package of 10 only, order 206-0230-03 (CR).

ORDERING INFORMATION

P6420 Rf Probe, 2 m Cable Included, 010-6420-03 . . . . . $120

For a 1 meter length cable, (does not change specifications)
175-1661-00 . . . . . $23

For a 3 meter length cable, (does not change specifications)
175-1661-02 . . . . . $23

ACCESSORY POUCH

While the TM 501, TM 503, TM 504, and TM 506 Mainframes were designed primarily for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500 Mainframe or Tektronix Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions approx 9¼ in long x 5¾ in wide x 2 in high.

Order 016-0351-00 . . . . . $25

TM 500 CARRYING CASE

These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½ inches long by 8½ inches thick by 15½ inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200 Series Miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert which will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 61.0 cm long x 21.6 cm thick x 44.5 cm high, (24 in. long by 8.5 in. thick by 17.5 in. high) and weighs approximately 14 pounds empty.

ORDERING INFORMATION

Carrying Case for TM 503 016-0565-00 . $300

Carrying Case for TM 504 016-0608-00 . $340

50 Ω PRECISION COAXIAL CABLE

For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

50 Ω Cable, Order 012-0482-00 . . . . . $25

HIGH VOLTAGE PROBE FOR USE WITH DMMs

The High Voltage Probe will measure dc voltages from 1 kV to 40 kV with an accuracy of 1% at 25 kV. The division ration is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes.

This probe plugs directly into the front end of either multimeter.

CHARACTERISTICS

Voltage range	1 kV to 40 kV dc
Input resistance	1000 MΩ
Division ratio	1000:1
Overall accuracy	20 kV to 30 kV 2%
Upper limit accuracy	Changes linear from 2% at 30 kV to 4% at 40 kV
Lower limit accuracy	Changes linear from 2% at 20 kV to 4% at 1 kV
Input Z at meter	10 MΩ required

Order 010-0277-00 . . . . . $105

NEW P6125 COUNTER PROBE 5X

The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

SPECIFICATIONS

Attenuation — 5X.
Input Resistance — 5 MΩ Input.
Capacitance — Approx. 20 pF.
Bandwidth — Dc to 200 MHz.
Voltage Rating — 250 V (dc + peak ac) derated to 35 V at 100 MHz.
Cable Length — 1.5 meters.

INCLUDED ACCESSORIES

352-0351-00	1 **HOLDER,** probe
013-0107-03	1 **TIP,** retractable hook
*	1 **TIP,** IC tester
**	2 **TIPS,** probe
344-0046-00	2 **CLIPS,** miniature, alligator
175-0124-01	1 **LEAD,** ground, 13 cm
175-0263-01	1 **LEAD,** ground, 8 cm
166-0404-01	1 **SLEEVE,** insulating
016-0521-00	1 **POUCH,** accessory

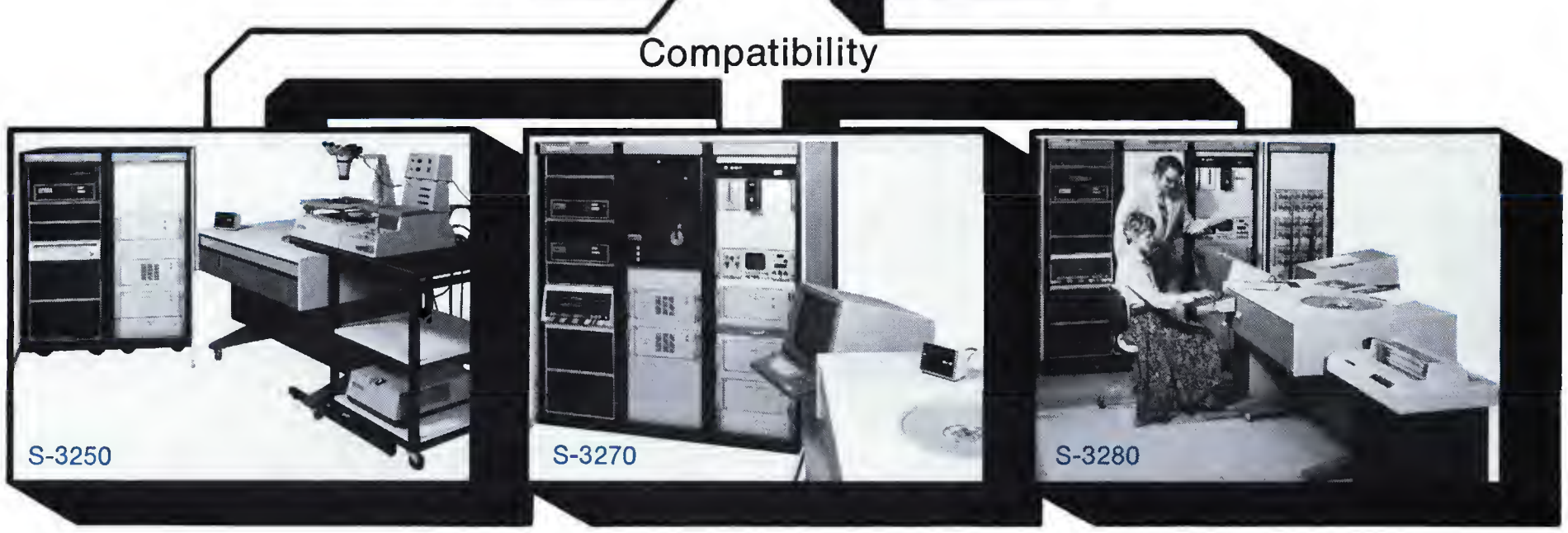
*Available in packages of 10 (015-0201-01) or 100 (015-0201-02) only.
**Available in packages of 10 only (206-0191-01).

P6125 Counter Probe, 5X, 1.5 m, 010-6125-01 . . . . . $50

Semiconductor Test Systems

TekTest Software

Compatibility



Need to test complex devices?

Tektronix has the solution.

At Tektronix, we've looked to the future to see what test problems the new device technology will create. Problems like increased complexity, faster speeds and higher pin count are only a few which continue to shape the rapidly changing device technologies. We've created a complete line of automated test systems to be ready to solve the problems of today . . . and tomorrow.

The S-3200 Series can Solve your device testing problems

Tektronix is ready now to provide the expertise, people, systems and software to tackle your existing test problems as well as the future problems you'll encounter. New or unusual device parameters do not present an impossible task. The versatility that's built into every S-3200 system is based upon field proven hardware and software that gets the job done.

Only one software language to learn . . . TEKTEST

Each system uses the same highly advanced software . . . TEKTEST. Using TEKTEST, the test engineer can easily and quickly generate, edit, and debug programs for device testing or characterization and then transfer these programs from one system to the other. And, using our foreground-background capability, up to four users can be programming or compiling data in the background while testing occurs uninterrupted in the foreground. Also, Terminal Control Mode, our powerful debug tool, gives the test engineer total control of the test problem. Ease of operation simplifies testing. And, all the systems feature highly sophisticated data reduction and graphics, making the test results manageable and easily understood.

New devices present New challenges

New devices such as codecs, linears, and the ever-changing digital ICs present continual evolving complexity in device testing. And, the increasing amount of both analog and digital on the same chip continues to push technology. Tektronix offers the analog and digital capability to meet these unique test requirements. In fact, captive manufacturers of devices buy Tektronix systems for this advantage. Tektronix, also a captive device manufacturer, has been testing their own hybrids over the years, and this expertise provides an in-depth understanding in device testing.

At Tektronix, we've built on our past experience and knowledge about device testing to create a total, compatible line of LSI/IC test systems that can help solve your test problems — now and in the future.

S-3250

TekTest

"Fast, efficient, accurate, production test system."

- Interfaces with popular handlers and probers
- 20 MHz clock rate
- High through-put
- Minimum operator interface
- Fast change-over
- Uses TEKTEST III
- Easy to program and edit
- Maximum system run-time, since programming can occur during testing.

Up to 64 D70 Pin Electronics Cards
Each with:
Independent I and O pins
Independent drive and compare levels
4 K shift register pattern memory
D.C. and 50 Ω access to I and/or O
Independent I/O switching control

7 Phase Clock Generator
Free running or externally synchronized modes
1 ns positioning resolution of all edges
Up to 20 MHz maximum clock rate
Optional 14 phase clock

D.C. Parametric Stimulus System
Force voltage 0 to ±100 V in 10 mV increments
Optional force voltage =0 to ±10 V in 1 mV increments
6 dut power supplies with programmable current limit and Kelvin sensing
Force current from 0 to ±200 mA in 1 μA increments
Optional force current ±1 nA full scale

50 Ω Switching Matrix
2 channels standard, 4 channels optional
High fidelity analog stimulus path to dut
High fidelity analog measurement path from dut, direct or buffered

D.C. Parametric Measurement System
Differential or single ended voltage measurements
Measure voltage range from ±100 mV full scale to ±100 V full scale
Measure current range from ±100 nA full scale to ±450 mA full scale
Optional current measurement range from ±100 pA to ±100 nA full scale

Foreground/Background Disk Operating System
Floating point hardware for calculating speed
Multi-user environment for program development and data analysis
TEKTEST III™ High level software language
Interactive program debugging mode (PDM) terminal control mode (TCM)
Graphics data capability in user programs
Complete Utility Program Library

Full User Support Program
Verdict system diagnostic and verification package
RECAL computer guided system recalibration package
Spares kits for system items and options
90 days on-site warranty (parts and labor)
Applications training
Maintenance training

Optional Single-Shot Time Measurement System
Triggerable to allow functional preconditioning
Uses functional comparators for strobing and level detection
50 ps resolution (100 ns range)

Optional Pattern Random Access Memory (PRAM)
1 K or 4 K memory depth
32 bits control and 64 bits pattern data
Match mode (start when ready)
Pattern source selection (S/R or PRAM) on-the-fly
Loop and subroutine capability for pattern compression

Optional Instrumentation
IEEE Bus interface
Digital Voltmeters
Digital Counters
Pulse Generators
Waveform Synthesizers

Optional Waveform Digitizer
2 channels simultaneously digitized
2 mV per division to 25 V per division
100 ps per division to 500 ms per division
Triggerable with system clock or external instruments
Software for signal averaging, pulse analysis, Fast Fourier Transform, Harmonic Distortion, etc.
Vertical and Horizontal Internal References

Optional Memory Pattern Generator
Independent X and Y address generators, up to 12 bits each
Data generator up to 32 bits
Algorithmically programmed
Stores error addresses as test proceeds at clock rate

S-3270

TekTest

"The ultimate device characterization/ production test system."

- Uninterrupted Error Storage at 20 MHz
- Multiple pattern sources
- Versatile driver formats
- 14 programmable channels of timing information
- Test devices with up to 128 pins
- Single-shot timing
- Advanced graphics and data reduction
- Uses TEKTEST III, a device-oriented test language
- Easy to program and edit
- True foreground/background timesharing

Up to 64 D70 Pin Electronics Cards
Each with:
Independent I and O Pins
Independent drive and compare levels
4 K shift register pattern memory
D C and 50 Ω access to I and/or O
Independent I/O switching control

14 Phase Clock Generator
Free running or externally synchronized modes
1 ns positioning of all edges
Up to 20 MHz maximum clock rate

Pattern Random Access Memory (PRAM)
1 K memory depth (4 K optional)
32 bits control and 64 bits pattern data
Match mode (start when ready)
Pattern source selection (S/R or PRAM) on-the-fly
Loop and subroutine capability for pattern compression

D C Parametric Stimulus System
Force voltage 0 to ±100 V in 10 mV increments
Optional force voltage 0 to ±10 V in 1 mV increments
6 dut power supplies with programmable current limit and Kelvin sensing
Force current from 0 to ±200 mA in 1 μA increments
Optional force current ±1 nA full scale

D C Parametric Measurement System
Differential or single ended voltage measurements
Measure voltage range from ±100 mV full scale to ±100 V full scale
Measure current range from ±100 nA full scale to ±450 mA full scale
Optional current measurement range from ±100 pA to ±100 nA full scale

Single-Shot Time Measurement System
Triggerable to allow functional preconditioning
Uses functional comparators for strobing and level detection
50 ps resolution (100 ns range)

50 Ω Switching Matrix
4 channels standard
High fidelity analog stimulus path to dut
High fidelity analog measurement path from dut, direct or buffered

Foreground/Background Disk Operating System
Floating point hardware for calculating speed
Multi-user environment for program development and data analysis
TEKTEST III™ high level software language
Interactive program debugging mode (PDM)
Terminal control mode (TCM)
Graphics data capability in user programs
Complete utility program library

Full User Support Program
Verdict system diagnostic and verification package
RECAL computer guided system recalibration package
Spares kits for system items and options
90 days on-site warranty (parts and labor)
Applications training credits
Maintenance training credits

Optional Waveform Digitizer
2 channels simultaneously digitized
2 mV per division to 25 V per division
100 ps per division to 500 ms per division
Triggerable with system clock or external instruments
Software for signal averaging, pulse analysis, fast fourier transform, harmonic distortion, etc.
Vertical and horizontal internal references

Optional Memory Pattern Generator
Independent X and Y address generators, up to 12 bits each
Data generator up to 32 bits
Algorithmically programmed
Stores error addresses as test proceeds at clock rate

Optional Instrumentation
IEEE Bus interface
Digital voltmeters
Digital counters
Pulse generators
Waveform synthesizers

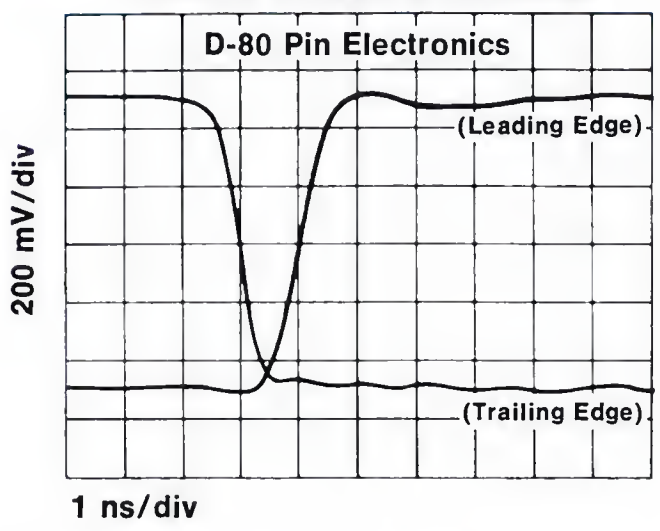
S-3280

TekTest

"Ultra high-speed logic device testing with superb accuracy."

- 100K ECL testing
- Precision fixturing
- Sub-nanosecond measurements
- Full graphics and data reduction package
- High speed drivers
- Sampling for Waveform Analysis
- Uses TEKTEST III
- Simple to program and edit
- Tests high speed logic
- CML capability

TYPICAL DRIVER WAVEFORM



Up to 64 D80 Pin Electronics Cards

Each with:
Sub-nanosecond driver
High accuracy 50 Ω comparators
Independent drive and compare levels
4 K local memory pattern
D.C. and 50 Ω access to I and/or O
Independent I/O switching control

7 Phase Clock Generator

Free running or externally synchronized modes
1 ns resolution of all edges
Up to 20 MHz maximum clock rate

Pattern Random Access Memory (PRAM)

1 K memory depth (4 K optional)
32 bits control and 64 bits pattern data
Match mode (start when ready)
Pattern source selection (local memory or PRAM) on-the-fly
Loop and subroutine capability for pattern compression

DC Parametric Stimulus System

Force voltage from 0 V to ±40 V in 10 mV steps
Force voltage from 0 V to ±10 V in 1 mV steps
6 dut high resolution power supplies with programmable current limit and Kelvin Sensing
Force current 0 A to ±200 mA in 1 μA steps
Optional CF-1 force current from 0 A to 200 μA; 0.05% resolution

DC Parametric Measurement System

Differential or single ended voltage measurements
Measure voltage range from ±200 mV full scale to ±40 V full scale
Measure current range from ±100 nA full scale to ±450 mA full scale
Optional current measurement range from ±100 pA to ±100 nA full scale

Single-Shot Time Measurement System

Triggerable to allow functional preconditioning
Uses functional comparators for strobing and level detection
50 ps resolution (100 ns range)

50 Ω Switching Matrix

2 channels for external access to/from each dut pin under programmable control
High fidelity analog stimulus path to dut
High fidelity analog measurement path from dut

Foreground/Background Disk Operating System

TEKTEST III™ high level software language
Multi-user environment for program development and data analysis
Interactive program debugging mode (TCM) Terminal control mode
Floating point hardware for calculating speed
Graphics data capability in user programs
Complete utility program library

Full User Support Program

VERDICT system diagnostic and verification package
RECAL computer guided system recalibration package
Spares parts kits available for system items and options
90 days on-site warranty (parts and labor)
Applications training
Maintenance training

Optional Waveform Digitizer

2 channels simultaneously digitized
2 mV per division to 200 mV per division
100 ps per division to 500 ms per division
Triggerable from system clock or external instruments
Software for signal averaging, pulse analysis, Fast Fourier Transform (FFT), Harmonic Distortion THD, etc.
Vertical and horizontal internal references

Optional Memory Pattern Generator

Independent X and Y address generators, up to 12 bits each
Data generator up to 32 bits
Algorithmically programmed
Stores error addresses as test proceeds at clock rate

Optional Instrumentation

IEEE Bus interface
Digital voltmeters
Digital counters
Pulse generators
Waveform synthesizers
Power supplies

100 K Series ECL Fixturing

Accurate measurements on 100 K ECL devices

Standard ECL Fixturing

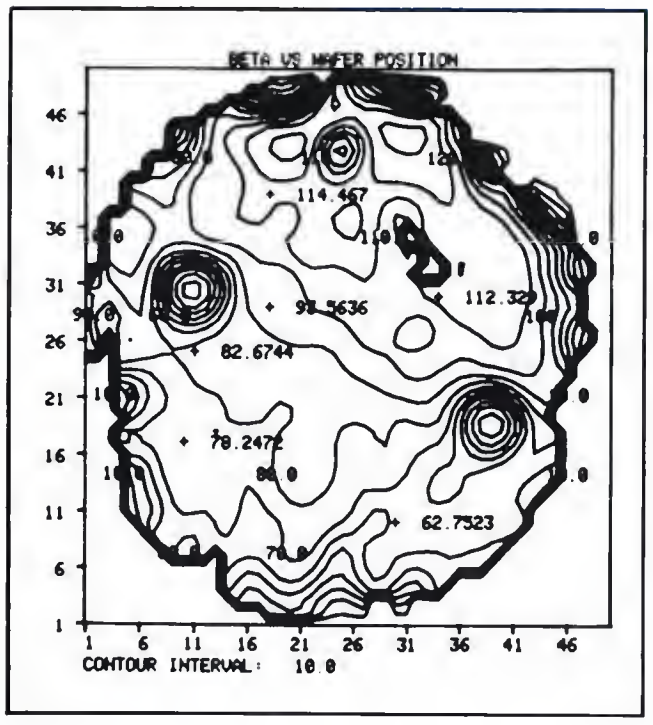
Individually wired for specific device type
Accepts zero insertion force (ZIF) sockets

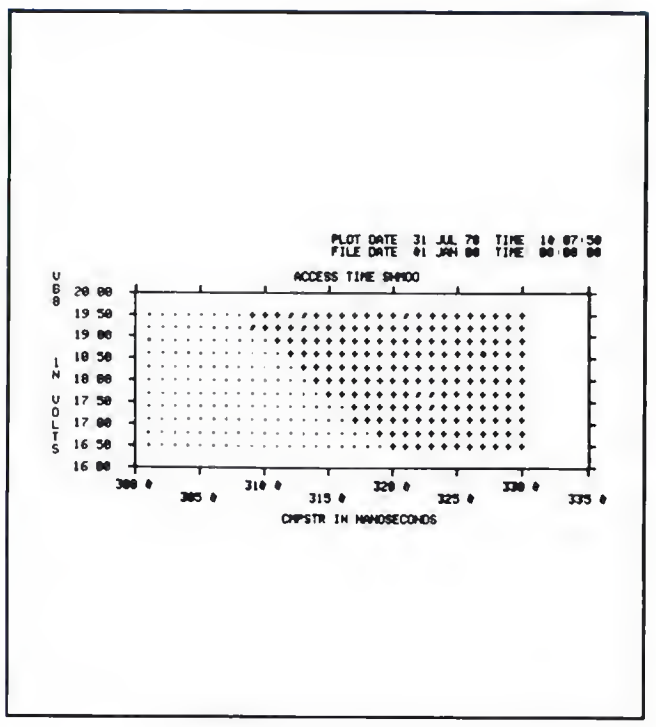
Optional 50 Ω Prober Interface

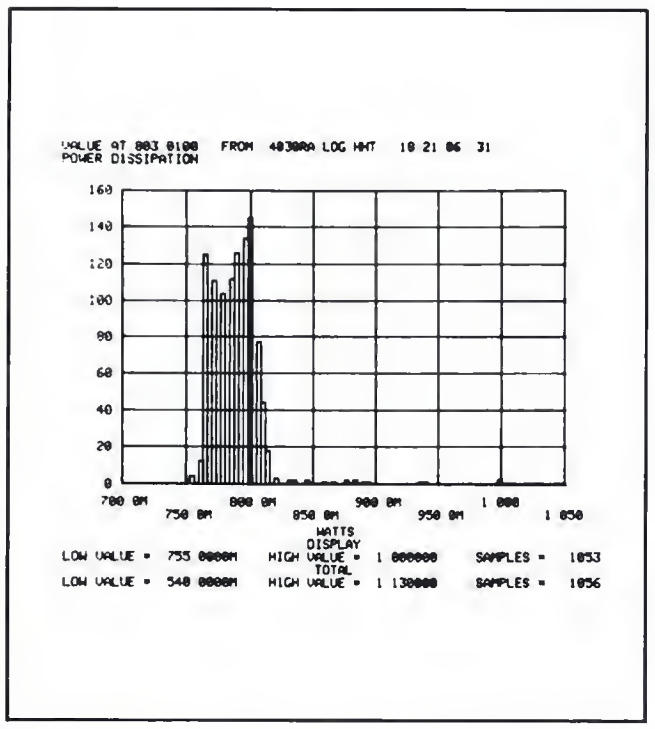
Accurate measurement on ECL devices at wafer level
50 Ω impedance maintained up to prober pins

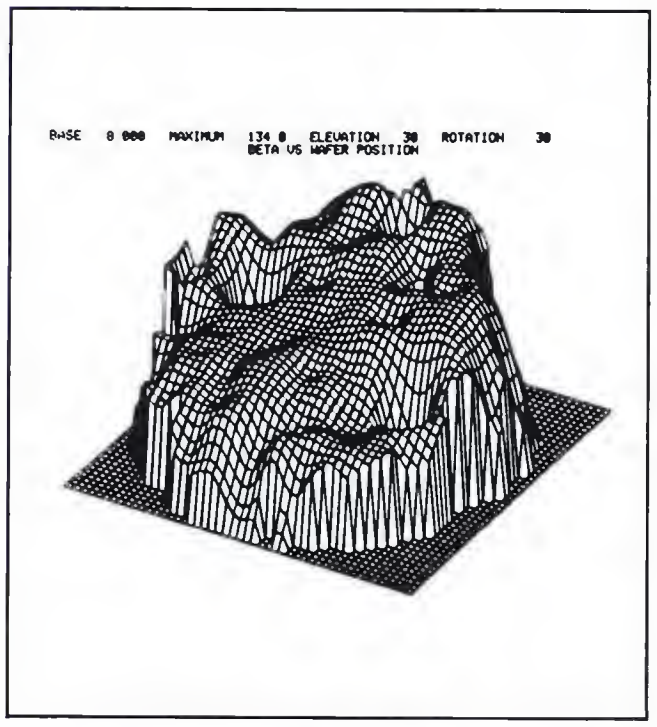
Optional current mode logic (CML) test capability

Graphics









The language of these systems is TEKTEST III. It's a device-oriented language, and is easy to read and understand since it's very close to English. The architecture of the system was designed so that programming, editing and debugging all use TEKTEST III. When making corrections in a program, there is no need to use a "bridge" language between the source language and the machine language. Everything is written in TEKTEST III. This capability, which we call Terminal Control Mode, gives the test engineer total control of the program. When editing a program during the test, the test engineer can hold power to the device, make the change, and continue the test. There's no need to re-sequence the program. And, since the systems also feature true foreground/background timesharing, up to four test engineers can be using terminals that can be interfaced to the system, and the system will continue to test devices without any through-put loss. Terminal Control Mode and true foreground/background make the S-3200's simple and fast to program and edit.

The more complex a device, the more information you need about that device. But with complexity can come confusion . . . unless your test system makes the picture clearer.

The S3200 Series systems provides you with the graphics capability to reduce testing data to manageable, usable form.

Training & Support.

When you purchase your S-3200 System, we'll train your test engineers for you. We'll give you plenty of documentation to give your engineers continuous support. We'll show them how to get the most out of this advanced software system, and we'll show them how to save time on the system. When future testing problems get really tough—and they will—you'll have engineers who know how to cut your test time by using the S-3200 Systems.

Tektronix offers basic and advanced training classes in both programming and maintenance of the S-3200 Series of Automated Test Systems. For further training information, contact your local Field Office or request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

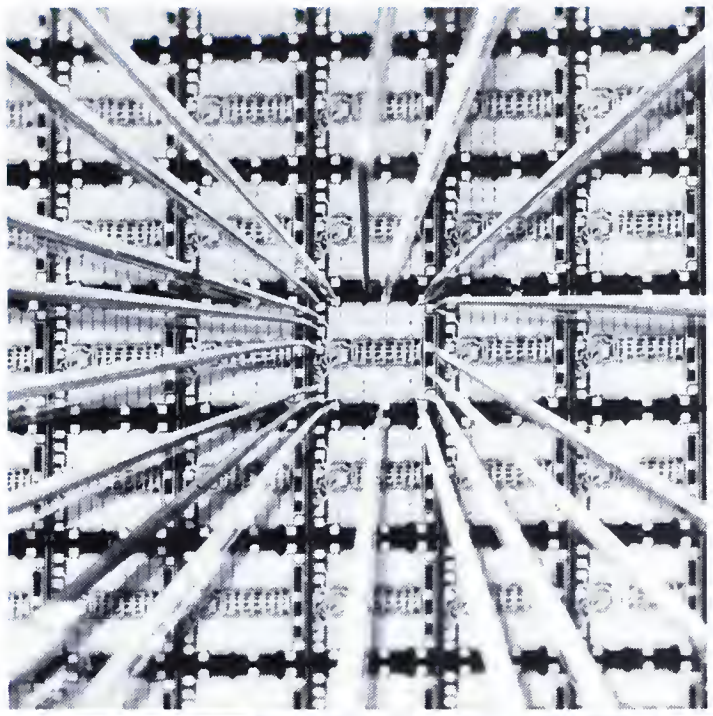
Serious about reliability?

Then you need to know about Tektronix Test Systems.

At Tektronix, new product designers team up with specialists in IC technology and testing known as Component Evaluation Engineers. Using their combined expertise, the team compiles information on the devices that seem to fit the application and then narrow the list to a few good candidates. Now, Component Evaluation Engineers begin their most important function; thoroughly evaluating the performance and reliability of each candidate device.

The evaluation process begins by investigating those device parameters and functions most critical to the intended application. This sometimes leads to a complete device characterization, a process that requires exhaustive testing.

When an IC is characterized, every measurable parameter and function is tested, actual limits of performance are determined, and then device behaviour is documented for all the various sets of input conditions in all their combinations and permutations. That's a lot of testing and it can quickly build mountains of test data. A system that performs accurate and reliable tests is not enough. The Component Evaluation Engineer must also have the tools to reduce the data mass into a usable form. For device characterization, the engineer needs a combination general purpose IC test system and a data processing system — a totally integrated package that both acquires and processes test and measurement data.



Tektronix Component Evaluation Engineers find all the qualities described above in TEKTRONIX S-3200 Series Automated IC Test Systems. These systems are used for device characterization, field failure analysis, IC process evaluation, and incoming inspection.

Tektronix LSI-IC test systems are used by the world's leading telecommunications companies, aerospace contractors, computer manufacturers, semiconductor manufacturers, and by the military. Serious about reliability? Then you should know about Tektronix IC test systems.

For more information contact the semiconductor test and systems sales specialist nearest you.

For more information about the S-3200 Automated Test Systems, contact the Test Systems specialists located in the following Offices:

Portland, OR

Los Angeles, CA

Boston, MA

Philadelphia, PA

Dallas, TX

Tektronix U.K., Ltd.
Harpenden, England

Tektronix
Orsay, France

Tektronix AB
Solna, Sweden

Tektronix Holland N.V.
Badhoevedorp, Holland

Rhode & Schwartz Vertriebs GmbH.
Koln, Germany

Tektronix Spa
Milano, Italy

Tektronix International A.G.
Zug, Switzerland

Sony/Tektronix Corporation
Tokyo, Japan

Curve Tracers

Curve tracers can deliver comprehensive information about a multitude of semiconductor devices and integrated circuits . . . from two- and three-terminal devices through the full range of linear integrated circuits . . . from transistors and diodes to optoisolators, thyristors, and operational amplifiers.

These versatile measurement tools give you more than pinpointed parameters. A curve tracer can show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions (p 229-238) helpful in choosing the system that best meets your requirements. If you would like to receive a brochure, application notes, and other materials to learn more about Curve Tracers and their measurement capabilities, please use the reply card on the inside back cover; or, for faster action, contact a Tektronix Sales Engineer at the Field Office nearest you.

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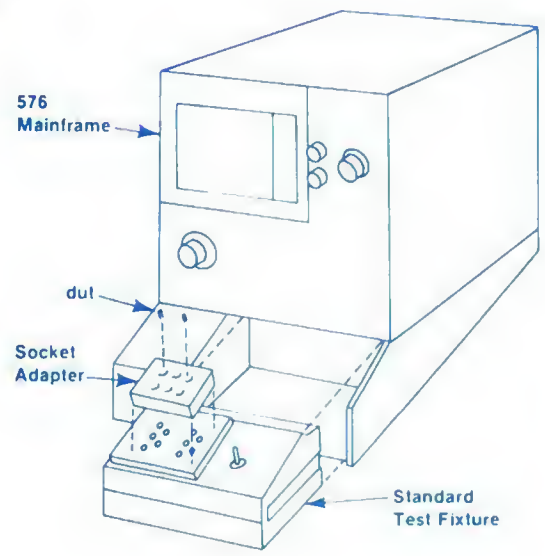
Curve Tracer System



576

Tests two and three terminal discrete semiconductors

Power capability up to 220 W

Convenient scale factor readout

Other test fixtures for testing power devices and semi-automated testing

The TEKTRONIX 576 Curve Tracer System continues to hold the title "standard of the industry." The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (described on p 232), and the 176 Pulsed High-Current Fixture (described on p 233). The 576 is an excellent general purpose curve tracer system that performs well in applications where high current testing is required.

With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the device under test. The step generators can deliver up to 2 A in both its current and voltage modes of operation. Of course, with the 176, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the 577 is the display area READ-OUT. Adjacent to the 576's CRT are alphanumeric indicators of vertical and horizontal deflection factors, step amplitude, and Beta/div or gm/div. The Beta or gm readout saves the operator from the arithmetic usually necessary to arrive at these parameters. The READ-OUT also provides a permanent record of major knob settings in 576 CRT photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer are: adjustable current limiting in the step generator, either 300 μs or 80 μs pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and illuminated graticule.

CHARACTERISTICS

COLLECTOR SUPPLY

Modes — NORM: positive or negative full wave rectified ac (line frequencey); dc: positive or negative dc; LEAKAGE: emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

Voltages — Peak open circuit voltages within +35% and −5% of indicated range.

Range	15 V	75 V	350 V	1500 V
Max Continuous Peak Current	10 A	2 A	0.5 A	0.1 A
Peak Pulse Mode Current	≥20 A	≥4 A	≥1 A	≥0.2 A

Series resistance is from 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak power limit setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

Safety Interlock — Protects operator from 75 V, 350 V, and 1500 V collector voltages.

STEP GENERATOR

Current Mode — Step/offset amplitude range is 5 nA/mV/step (with X0.1 MULT) to 2 V/step, 1-2-5 sequence. Max current (steps and aiding offset) is X20 AMPLITUDE setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Max voltage (steps and aiding offset) is at least 10 V. Max opposing offset current is X10 AMPLITUDE switch setting or 10 mA, whichever is less. Max opposing voltage is limited at 1 V to 3 V.

Voltage Mode — Step/offset amplitude range is 5 mV/step (with X0.1 MULT) to 2 V/step, 1-2-5 sequence. Max voltage (steps and aiding offset) is X20 AMPLITUDE switch setting, 40 V max. Max current (steps and aiding offset) is at least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short circuit current limiting is 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Max opposing offset voltage; X10 AMPLITUDE switch setting. Max opposing current; limited at 5 mA to 20 mA.

Accuracy — Incremental; within 5% between steps, within 10% with X1.0 MULT. Absolute; within 2% of total output including offset, or 1% of AMPLITUDE setting, whichever is greater. Offset multiplier; 0 to X10 the AMPLITUDE setting, continuously variable. Polarity AID(s) or OPPOSE(s) the step polarity.

Step Rates — X0.5, X1 (NORM), and X2 the collector supply rate. The collector supply rate is twice line frequency.

Pulsed Steps — Approx 80 μs or 300 μs width, at NORM or X0.5 rates.

Step/Offset Polarity — The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity, and positive in the ac position. Step polarity may be inverted by actuating the INVERT pushbutton.

Step Family — REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps — Digitally selectable between 1 and 10.

DEFLECTION CONTROLS

Display Accuracies — As a percentage of highest on-screen value.

		OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
NORM and DC MODES	**NORMAL**	**100-40 div**	**35-15 div**	**10-0 div**
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:				
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:				
≥1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20, or 2 nA	3% plus 50 mV/vert div			
500, 50, or 5 nA	3% plus 125 mV/vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

Vertical Deflection Factor — Collector current is 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/dIv with X10 magnification). Emitter current is 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step generator is 1 step/div.

Horizontal Deflection Factor — Collector volts; 50 mV/div to 200 V/div, 12 steps (5 mV/div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step generator; 1 step/div.

Displayed Noise — 1% or less or:

RANGE	15 V	75 V	350 V	1500 V
Vertical—Collector	1 μA	1 μA	2 μA	5 μA
Vertical—Emitter	1 nA	1 nA	2 nA	5 nA
Horizontal—Base	5 mV	5 mV	5 mV	5 mV
Horizontal—Collector	5 mV	5 mV	20 mV	200 mV

Calibrator (CAL) — Dc voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

Position Controls — Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

Display Offset — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 MAGNIFIER.

CRT and READOUT

CRT — 6.5 in. rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 Phosphor normally supplied.

Readout — The readouts, adjacent to CRT, are digital indicators of the following parameters: PER VERT DIV from 1 nA/div to 2 A/div; PER HORIZ DIV from 5 mV/div to 200 V/div; PER STEP from 5 nA/step to 2 A/step, 5 mA/step to 2 V/step; β (BETA) or g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and X0.1 MULT.

STANDARD TEST FIXTURE

Description — A plug-in fixture with two sets of 5 pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6 pin universal adapters, 3 pin adapters, or the high-power transistor adapters with KELVIN contacts.

OTHER CHARACTERISTICS

Power Requirements — Power Source; operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. Voltage Ranges; the quick-change line-voltage range selector accommodates 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10° C to +40°C.

Dimensions and Weights

	in	cm
Height	15.0	38.1
Width	11.5	29.2
Depth	23.0	58.4
	lb	**kg**
Net Weight	70.5	32.0
Shipping Weight	≈107	≈48.5

INCLUDED ACCESSORIES

Transistor adapter (013-0098-02), FET adapter (013-0099-02). TO3 adapter (013-0100-01), TO66 adapter (013-0101-00), axial lead diode adapter (013-0111-00), stud diode adapter (013-0110-00), Kelvin sensors for large and small plastic transistors (013-0138-01), and protective cover (337-1194-00).

ORDERING INFORMATION

576 Curve Tracer with Standard Test Fixture $7675

The 576 Option 01 deletes the parameter readout module but maintains provisions for insertion of the module (020-0031-00) at any time.

Order Option 01 ..... Sub $600

Auto Scale-Factor Readout Module
Order 020-0031-00 ..... $1100

OPTIONAL ACCESSORIES

Camera — See Oscilloscope/Camera Adapter chart in Camera section of this catalog.

Test Set-up Chart — Package of 250.
Order 070-0970-01 ..... $7

172 Test Fixture ..... See page 232
176 Test Fixture ..... See page 233
Socket Adapters ..... See page 237 & 238

Curve Tracer Programmable Test Fixture

172

Semi-automated test fixture

Tests up to 11 parameters

Reduces total test time

The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program a sequence of tests of J FETs, transistors, and diodes.

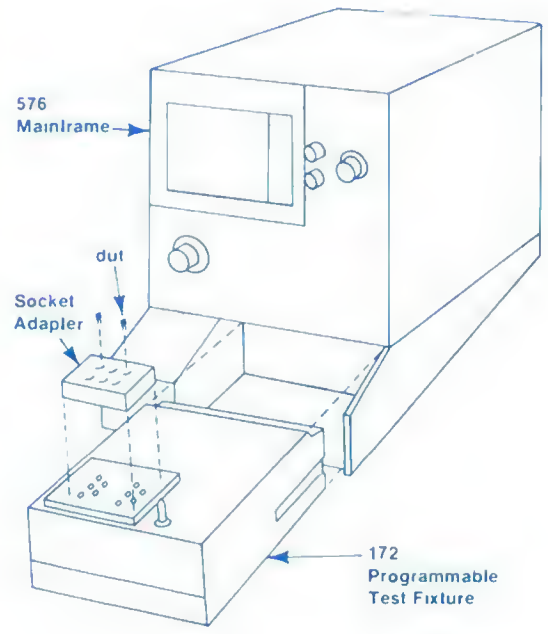
The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172 all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable RATE control is provided for the operator to set the test sequence at a rate which is best for him. New operators require more time per test, but with experience they will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

TESTS THAT CAN BE PERFORMED ON:				PROGRAMMABLE CAPABILITIES
Test	Xstr	J FETs	Diodes	
*1	H_{FE}, $V_{CE(sat)}$	V_P	V_F	PEAK CURRENT up to 10 A PEAK VOLTS up to 350 V.
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).
3	H_{FE}, $V_{CE(sat)}$	I_{DSS}, $R_{DS(on)}$		Base Drive: 100 nA to 110 mA. When testing J FETs the base terminal is shorted to the emitter terminal. Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively.
4	Same as #3.			
5	I_{CEO} or I_{CES}, I_{CER} with external short or resistor			Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is nA/div.
6	I_{CBO}	I_{GSS}		Same as #5.
7	I_{EBO}		I_R	Same as #5.
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 100 mA dc for breakdown voltage measurements to 50 V.
9	$V_{(BR)CES}$			Same as #8.
10	$V_{(BR)CBO}$	BV_{GSS}		Same as #8.
11	$V_{(BR)EBO}$		V_R	Same as #8.

*All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as for Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.

For the remaining tests the only 576 controls that are functional are the Polarity and CRT controls such as INTENSITY, FOCUS, DISPLAY OFFSET.



CHARACTERISTICS

VERTICAL AND HORIZONAL AMPLIFIERS

Display Accuracies — The same as the 576 Curve Tracer with its included Standard Test Fixture.

Vertical Deflection Factor — Tests 1 and 2 (Collector or Emitter Current): 1_c 1 μA to 2 A/div in 20 steps. Tests 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1μA to 0.5 A/div in 18 steps. Tests 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1-2-5 sequence.

Horizontal Deflection Factor — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for Test 2, at least 100 MHz at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Tests 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1-2-5 sequence.

Collector Sweep Voltage — At least 2 V open circut, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

Current Supply Accuracy — 0.1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ±30 nA with up to 50 V compliance. Increments of current are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA), 100 μA (from 1 mA to 11 mA), and 1 mA (from 10 mA to 110 mA).

Voltage Supply Accuracy — 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

Test Display Time Range (Automatic) — 300 ms or less to at least 2 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

Dimensions and Weights	in	cm
Height w/cover	6.5	16.5
Width	7.8	19.8
Depth	12.4	31.5
	lb	**kg**
Net weight	11.5	5.2
Shipping weight	≈18.0	≈8.2

Included Accessories — One protective cover, five programming cards, 250 programming card pins, five CRT overlay limit cards.

ORDERING INFORMATION

172 Programmable Test Fixture $3200

Pulsed High Current Curve Tracer Fixture

176

Tests power transistors

Tests up to 200 amps in pulsed mode

1000 watt capability

The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The step offset, when selected, is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the 576 in regard to width and repetition rate.

The pulse width is selected by depressing the 300 μs or 80 μs pushbutton on the 576 Mainframe (usually, 300 μs should be selected). The rep rate is automatically set when the 176 is inserted in the mainframe. Rep rate is also dependent on power-line frequency. The five highest VERTICAL CURRENT/DIV (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 VERT pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest STEP GENERATOR AMPLITUDE base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 STEP pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 VERT and X10 STEP pushbuttons provide inputs to the fiberoptic readout to display actual values.

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

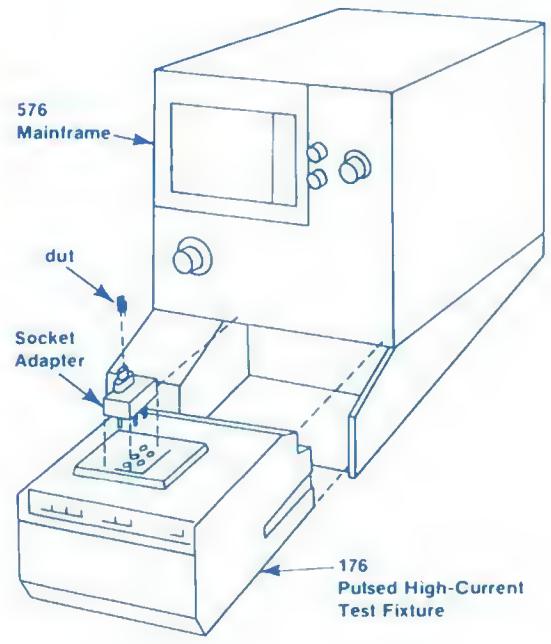
Width — 300 μs or 80 μs determined by 576.

Repetition Rate — Power-line frequency.

Polarity — + or − determined by 576 polarity control.

Amplitude — Ranges are 15, 75, 350 V nominal, controlled by MAX PEAK VOLTS switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.

Max Peak Watts — Three illuminated pushbuttons select 10, 100, 1000 W max peak power.



STEP GENERATOR

Current Ranges (X10 STEP selected) — Step-Offset Amplitude Range is 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Max Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Max Voltage (Steps and Aiding Offset) is at least 5 V up to 10 A and 2 V up to 20 A.

576 Offset Multiplier — 0 to X100 576 AMPLITUDE switch setting.

Step Rate — Power-line frequency.

Pulsed Steps — 300 μs or 80 μs wide.

Step/Offset Polarity — The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity. Step polarity may be inverted by actuating the INVERT pushbutton.

Accuracy (Current steps including offset) — Incremental is within 5% between any two steps; within 10% with 0.1X STEP MULT. Absolute is within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.

VERTICAL AMPLIFIER

Deflection Factor (X10 VERT selected) — 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over a temperature range of 0°C to +40°C.

Dimensions and Weights	In	cm
Height	4.6	11.7
Width	7.9	20.1
Depth	11.4	29.0
	lb	**kg**
Net weight	12.8	5.8
Shipping weight	18.0	8.2

Included Accessories — TO36 adapter (013-0112-00); stud diode adapter (013-0110-00); protective shield (337-1194-00).

ORDERING INFORMATION

Order 176 Pulsed High-Current Fixture $3625

Storage and Non-Storage Curve Tracer Systems

577

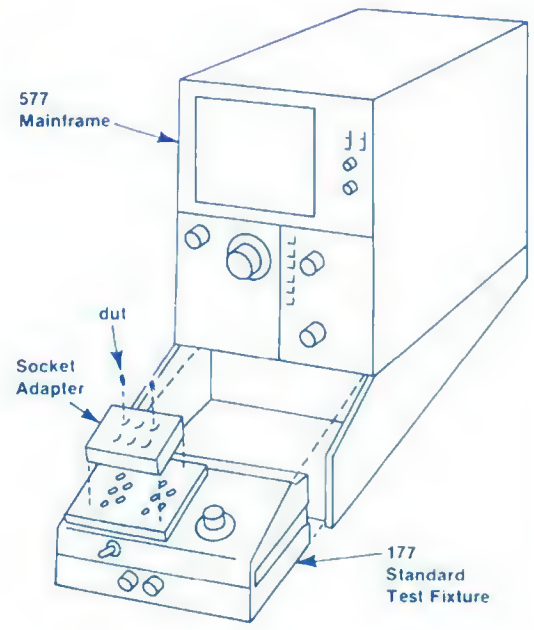
Test two and three terminal discrete semiconductors

Storage capability

Power capability up to 100 watts

The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are storage and the emphasis on low current measurements.

The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op amp testing because the open-loop 3 dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see page 236).



In the 577/177 Curve Tracer System several features facilitate low current measurements. They include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available, 10 A continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Modes — Five modes of collector supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc, or negative dc.

Voltage — The voltage is variable to the max peak volts selected.

Max Peak Volts Open Circuit	6.5 V	25 V	100 V	400 V	1600 V
Continuous Current, Peak	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

Series Resistance — 14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains max peak power to the device under test when changing voltage ranges.

Safety Interlock — Protects operator from 100, 400, and 1600 volt ranges. Momentary button provides for overriding interlock.

STEP GENERATOR

Current Mode — Step amplitude range is 5 nA/step (with STEP X0.1) to 200 mA/step, in a 1-2-5 sequence. Available current is at least 2 A on the highest amplitude setting with 5 V or more compliance. For opposing offset, available current is at least 10 mA with voltage limited between 1 V and 5 V.

Voltage Mode — Step amplitude range is 5 mV/step (with STEP X0.1) to 2 V/step, in a 1-2-5 sequence. Current is limited between 100 mA and 200 mA. For opposing offset, available current is at least 10 mA (at 0 V) derating to 0 mA at 20 V.

Accuracy — Incremental; within 2% between steps. Absolute; within 3% of total output or AMPLITUDE setting, whichever is greater. When STEP X0.1 is actuated the absolute step accuracy is 4%.

Step Rate — Selectable at X1 (SLOW), X2 (NORM), or X4 (FAST) line frequency.

Pulsed Steps — Steps can be gated for a duration of approx 300 μs for testing at low duty cycle.

Step/Offset Polarity — With NORM POLARITY selected, the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with STEP/OFFSET POLARITY control or from the test fixture.

Offset — The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either AID or OPPOSE steps. Max range of offset is 10 full-amplitude steps.

Step Family — Repetitive or single family.

Number of Steps — Selectable from 1 to 10 full-amplitude steps. Selectable up to approx 95 steps when using STEP X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies — As a percentage of highest on-screen value.

Display Mode	Normal	Magnified
Vert Collector Current	3% ±1 nA	4% ±1 nA
Horiz Collector Volts	3%	4%
Horiz Base Volts	3%	4%
Horiz Step Gen	4%	5%

Vertical Deflection Factor — Collector current is 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

Horizontal Deflection Factor — Collector volts; 50 mV/div to 200 V/div, 12 steps in a 1-2-5 sequence (5 mV/div to 20 V div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps in a 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification). Step generator; 1 step/div (0.1 step/div with X10 magnification).

Automatic Scale Factor Readout — Change in deflection factor is indicated by lights behind the knob skirt when using X10 MAG.

Automatic Positioning — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

Display Invert — Single control inverts display and repositions trace.

Display Filter — Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

CRT

CRT — Rectangular 6.5 in. with an 8 x 10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to P1. The D2 display unit has a nonstorage CRT with P31 Phosphor. Accelerating potential is 3.5 kV.

Beam Finder — Compresses off-screen trace to within graticule area.

Ambient Temperature — Performance characteristics are valid over an ambient temperature of +10°C to +40°C.

Dimensions and Weights

	577/D1 or 577/D2		177	
	in	cm	in	cm
Height	19.8	50.3	4.0	10.2
Width	8.8	22.4	7.9	20.1
Depth	23.0	58.4	6.0	15.2
	lb	kg	lb	kg
Net Weight	40	18.1	2.5	1.1
Shipping Weight	50	22.7	6	2.7

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≃53 lb or ≃24 kg.

177 TEST FIXTURE

Device Lead Selection — Switch provides six different lead configurations. Three positions for EMITTER GROUNDED measurements provide STEP GEN, OPEN (OR EXT), and SHORT base terminal connections. Two positions for BASE GROUNDED measurements provide STEP GEN and OPEN (OR EXT) emitter terminal connections. One position provides for EMITTER BASE BREAKDOWN or leakage measurements up to 25 volts.

Left-Right Switch — Selects left or right test connections. Off in center position. Test connection area accepts all TEKTRONIX Curve Tracer adapters and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation — Reduces display loops due to test adapter capacitance and some device capacitance.

Variable Voltage Supply — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

OTHER CHARACTERISTICS

Power Requirements — 100, 110, 120 V ac or 200, 220, 240 V ac all within ±10%. 50 to 60 Hz, 155 W max at 110 V ac and 60 Hz.

INCLUDED ACCESSORIES

Transistor adapter for most bipolar transistors and some MOS FETs (013-0098-02), axial lead diode adapter with Kelvin sensing terminals (013-0111-00), protective shield for test connection area (337-1194-00).

ORDERING INFORMATION

577/D1 Storage Curve Tracer Mainframe **$4235**

577/D2 Nonstorage Curve Tracer Mainframe **$3670**

Option 10, 10 x 10 cm Graticule; available with either storage or nonstorage mainframe ..... **Add $55**

177 Standard Test Fixture **$875**

OPTIONAL ACCESSORIES

178 Linear Test Fixture; see following page for complete description **$2185**

Camera — C-5C, see page 268 for complete description **$425**

Cart — Tek Lab Cart, Model 3 (see pages 295 & 296). **Order Model 3** **$425**

Test Set-up Chart — package of 250 **Order 070-1639-00** **$7.50**

Device Adapter Sockets: see page 238 for complete description.

Curve Tracer Linear IC Test Fixture

178

Tests Single, Dual, or Quad:
Operational Amplifiers, Comparators
Differential Amplifiers, Regulators and more

Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary accurate low current measurement capability, test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 Mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adapter (see page 238) that interfaces the system to the device under test.

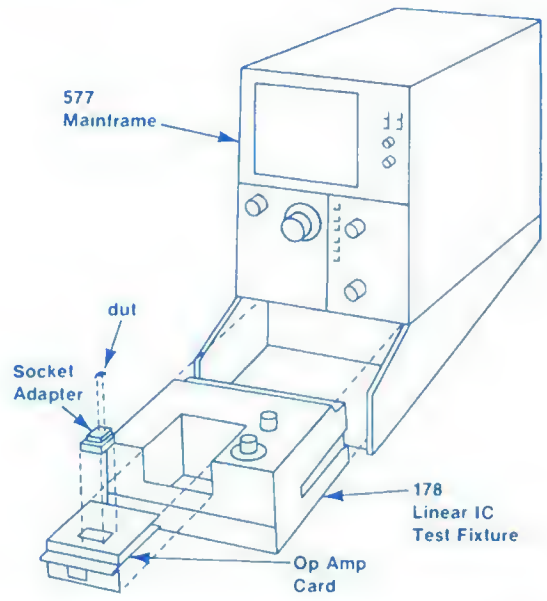
Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

OP AMP CARDS

The **Standard Op Amp Card** is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, cmrr, gain, positive and negative psrr, positive and negative supply current, and collector supply current.

The **Hardwire Card** is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device under test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The **Multiple Op Amp Card** allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as



those available with the Standard Op Amp Card.

Socket Adapters for Op Amp Cards — The device under test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adapters using the Amphenol-Barnes adapter system. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on page 238.

REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

Socket Adapters for Regulator Cards — Socket adapters for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adapters used on the standard curve tracer (see page 238).

CHARACTERISTICS

VERTICAL DEFLECTION (1-2-5 Sequence)	NORMAL	MAGNIFIED
Input Voltage or Δ Input Voltage	10 μV/div to 50 mV/div	1 μV/div to 5 mV/div
Accuracy	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 μA/div
Accuracy	3% ±50 pA	4% ±50 pA
Power Supply Current	0.1 μA/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy	3% ±0.1 μA	4% ±0.1 μA
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy	3% ±1 nA	4% ±1 nA

Accuracies are a percentage of highest on-screen values.

Power Supplies — Positive and negative supplies are adjustable from 0 to 30 V, available current is at least 150 mA with adjustable current limiting. The voltage of both supplies can be adjusted from a single calibrated control; accuracy is within 2% ±100 mV. Negative supply can be independently adjusted by an uncalibrated control.

Sweep Generator — A sinusoidal signal controls the output, common-mode input, or the power supply voltages of the device under test. The frequency is adjustable from 0.01 Hz to 1 kHz; amplitude is adjustable up to 30 V peak.

Source Resistance — For input resistor pairs selectable, 50 Ω, 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used. When the vertical deflection factor is in one of the less sensitive positions, 1 mV through 50 mV/div, the input resistance values are 550 Ω greater.

Load Resistance — Six selectable load resistors, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used.

Collector Supply — The 25 V and 100 V ranges of the Collector Supply (located on 577 Mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for Collector Supply performance.)

Step Generator — All the capabilities of the Step Generator (located on 577 Mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for Step Generator performance.)

DUT Supplies Disconnect — A single switch disconnects all power to the device under test: both plus and minus Power Supplies, Collector Supply, and Step Generator.

Function Switch — Selects vertical and horizontal deflection signals and connection of the test signal to the device under test.

Zero — Single pushbutton provides a zero reference to the CRT display and, in certain functions, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

Device Under Test Input Supply

INPUT VOLTAGE — Two ranges, 0-30 V and 0-60 V. 0-30 V is within ±2% ±200 mV of dial setting, and 0-60 is within ±2.5% ±300 mV of dial setting.

REGULATION — Within 200 mV.

INPUT SWEEP FREQUENCY — Dc to 1 kHz.

300 μs PULSED CURRENT — 5 mA to 2 A.

SHORT DURATION DC CURRENT (One minute)

Supply Voltage	Current
0 - 10	700 mA
10 - 20	350 mA
20 - 40	300 mA
40 - 60	120 mA

Device Under Test Current Load — 5 mA to 2 A within ±3% of 0 to 1.25 mA.

Device Under Test Comparison Output Dc Voltage Accuracy — 0-10 V range within ±1% ±20 mV; 0-100 V range within ±1% ±150 mV.

OTHER CHARACTERISTICS

Dimensions and Weights	in	cm
Height	4.5	11.4
Width	7.9	20.1
Depth	7.8	19.8
	lb	kg
Net Weight	3.3	1.5
Shipping Weight	8.0	3.6

Included Accessories — Dual-in-line 16 pin IC socket (136-0442-00). Standard Op Amp Card with cover and ten patch cords (013-0149-01), interchangeable nomenclature panel for function switch (333-1770-00).

ORDERING INFORMATION

178 Linear IC Test Fixture $2185

Standard Op Amp Card — (One included with 178)
Order 013-0149-01 ..... $250

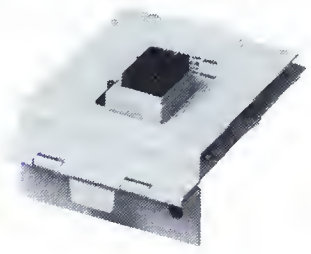
Hardwire Card
Order 013-0150-01 ..... $125

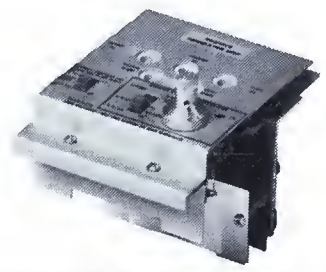
Multiple Op Amp Card (013-0155-00) $450

Positive Regulator Card
Order 013-0147-00 ..... $665

Negative Regulator Card
Order 013-0148-00 ..... $665

Standard Op Amp Card





Positive Regulator Card

Curve Tracer Plug-Ins for Oscilloscopes

5CT1N and 7CT1N

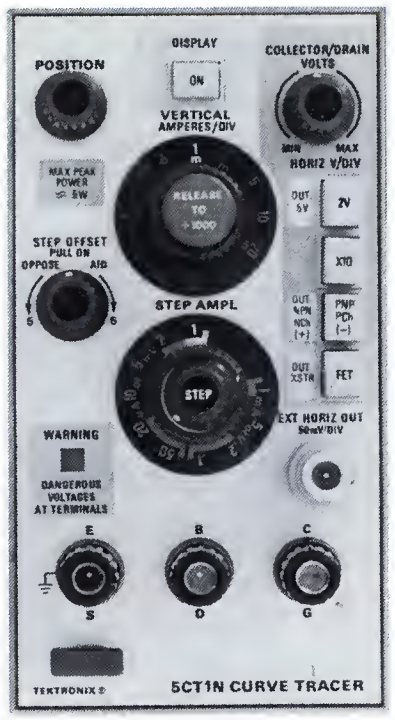
Tests Semiconductor Devices to 0.5 W

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

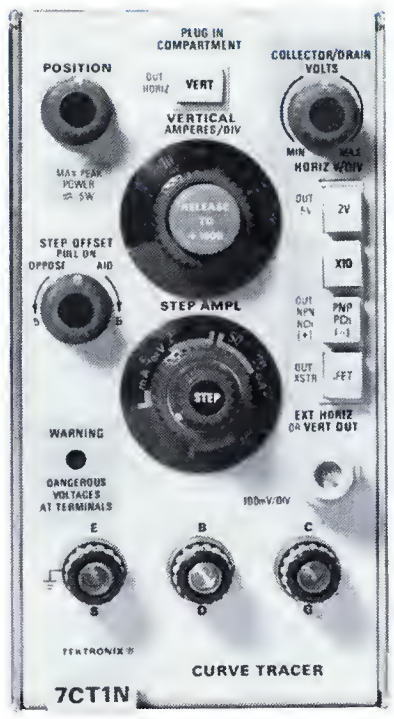
Easy to Operate

5CT1N



Curve Tracer

7CT1N



Curve Tracer

A

B

C

D

E

3 PIN ADAPTERS

The following accessories may be used with any of the Tektronix Curve Tracer products. They do not have Kelvin sensing contacts.

A. TO5 or TO18 Transistor Adapter — Order (013-0128-00) $22

B. Blank Adapter — For mounting special sockets. **Order (013-0073-00) $18**

C. TO3 or TO66 Transistor Adapter — Order (013-0070-01) $40

D. Diode Test Adapter — Holds axial-lead diodes. **Order (013-0072-00) $55**

E. Diode Test Adapter — Magnetically holds steel axial-lead diodes. **Order (013-0079-00) $150**

The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000 Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 5000 Series Oscilloscope Systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000 Series Oscilloscope Systems.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±20%. Max short circuit current, within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μA/step to 1 mA/step, 1-2-5 sequence. Max current (steps plus aiding offset) is X15 amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least 5X amplitude setting.

FET Mode — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is 15X amplitude setting, 13 V max. Source impedance is 1 kΩ ± 1%.

Accuracy — Incremental; within 3% between steps. Absolute; within ± (3% + 0.3X amplitude setting.)

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in one-step increments between 0 and 10.

Offset — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷1000 mode.

Horizontal Deflection Factors — Selectable: 0.5 V, 2 V, 5 V, or 20 V.

5CT1N Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the TEKTRONIX 5000 Series Plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 5000 Series Oscilloscope Mainframe.

7CT1N Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the TEKTRONIX 7000 Series Plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 7000 Series Oscilloscope Mainframe.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid from 0°C to +50°C.

	5CT1N		7CT1N	
Dimensions	**in**	**cm**	**in**	**cm**
Length	12.0	30.5	14.5	36.8
Width	2.6	6.6	2.8	7.1
Height	5.0	12.7	5.0	12.7
Weight	**lb**	**kg**	**lb**	**kg**
Net	1.8	0.8	2.5	1.1
Shipping	4.0	1.8	6.0	2.7

Included Accessories — Test Adapter (013-0128-00) with two sets of test terminals, one with TO5 basing and the other with TO18 basing.

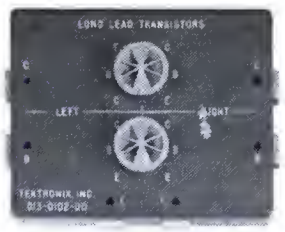
Order 5CT1N Curve Tracer $710

Order 7CT1N Curve Tracer $1240

Curve Tracer Socket Adapters

A

B



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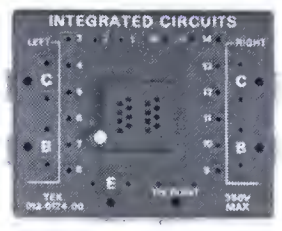


E

A

B

C

D

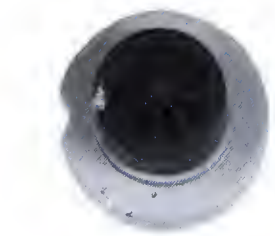
E

F

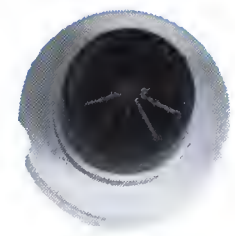
G

H

I



A



B

C

D

DUAL WIDTH ADAPTERS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

A. Transistor Adapter — Useful for most single and dual bipolar transistors and some MOS FETs.
Order (013-0098-02) **$150**

B. FET Adapter — Useful for most single and dual FETs.
Order (013-0099-02) **$150**

C. Long Lead Transistor Adapter — Accepts dual or single transistors with untrimmed leads.
Order (013-0102-00) **$110**

D. Long Lead FET Adapter — Accepts dual or single FETs with untrimmed leads.
Order (013-0103-00) **$120**

E. Integrated Circuit Adapter — Allows connection to multipin device packages. The appropriate multilead socket is plugged into the integrated circuits adapter. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Order the appropriate multilead socket listed separately.
Order (013-0124-01) Includes 8 each 4 inch test leads **$225**

KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

A. Transistor Adapter — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.
Order (013-0127-01) **$65**

B. In-Line Adapter — Accepts large and small transistors with in-line leads. The adapter will accept devices with approx spacing between terminals of 0.06 in. up to 0.18 in. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order (013-0138-01) **$65**

C. TO36 Adapter — Order (013-0112-00) **$65**

D. TO3 Adapter — Can be rewired to accommodate nonstandard configurations.
Order (0130-100-01) **$65**

E. TO66 Adapter —
Order (013-0101-00) **$65**

F. Axial Lead Diode Adapter —
Order (013-0111-00) **$75**

G. Stud Diode Adapter —
Order (013-0110-00) **$75**

H. Blank Adapter — For mounting special sockets.
Order (013-0104-00) **$55**

I. Power Transistor Adapter —
Order (013-0163-00) **$65**

MULTILEAD SOCKETS

These sockets are used with the Integrated Circuit Adapter (013-0124-01) listed under Dual Width Adapters, and with the 178 Test Fixture.

A. 8 Lead TO package —
Order (136-0444-00) **$30**

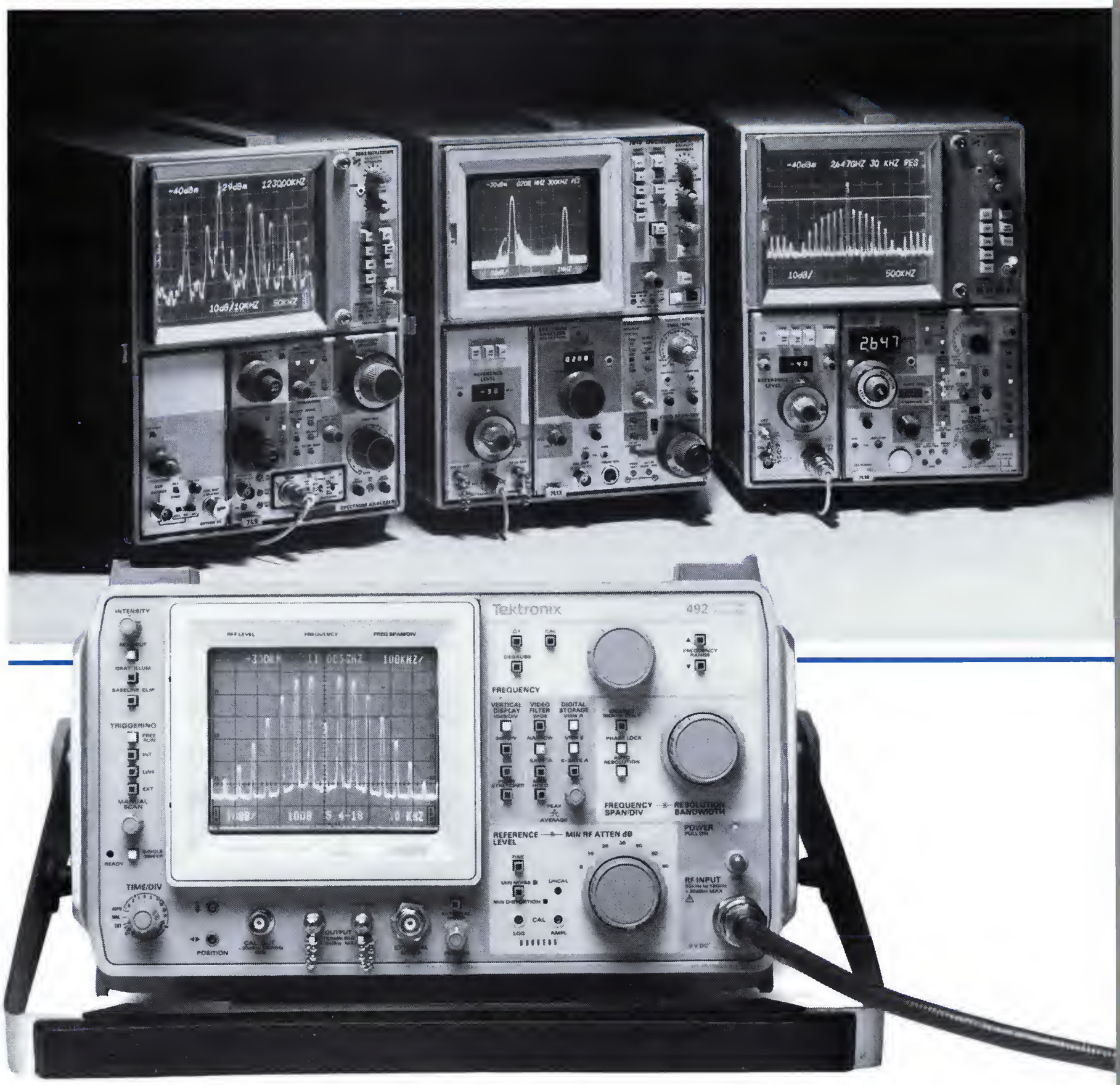
B. 10 Lead TO package —
Order (136-0441-00) **$30**

C. 14 Lead Dual-in-line package —
Order (136-0443-00) **$23**

D. 16 Lead Dual-in-line package —
Order (136-0442-00) **$30**

(These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.)

Spectrum Analyzers & Swept Frequency Systems



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50 kHz to 220 GHz Compact Spectrum Analyzers

492 **NEW 492P**

- Microprocessor Aided Controls
- Automatic Modes
- Portable Form Factor (Compact Size/Light Weight)
- Usable Frequency Range From 50 kHz to 220 GHz
- Amplitude Comparison in 0.25 dB Steps
- CRT Readout of all Important Parameters
- Fully Calibrated in Amplitude and Frequency
- 80 dB Dynamic Range
- Wide Range of Options
- GPIB Programmable
- Three-knob Operation
- Environmentalized per MIL-T-28800B
- Digital Storage and Signal Processing
- Freedom from Spurious Responses Through Preselection

GPIB Product

The 492P is designed to comply with IEEE Standard 488-1978, and with Tektronix *Codes and Formats* Standard. GPIB Interface Functions: Talk, Listen.

Lab quality you can get a handle on.

The 492 is a high performance, rugged, state of the art instrument of compact size, with microprocessor logic control. Full programmability via GPIB (IEEE 488-1978) compatibility is available for the 492P version.

Three-knob operation provides use as simple as 1, 2, 3 through microprocessor coupled functions such as resolution bandwidth, video bandwidth, sweep time, frequency span, rf attenuation, and reference level. Measurement accuracy is enhanced through the use of Δ dB mode, which switches in ¼ dB steps.

Digital storage and processing facilitate trace comparisons and add measurement capability through the max hold function for frequency drift and amplitude change measurements. Arithmetic operations can be performed between traces or between a trace and a reference. Digital noise averaging mode results in trace smoothing. With digital storage, the display is steady and without flicker, even at the lowest sweep speeds; plus, trace values may be retained as long as power is on.

492P makes spectrum analysis automatic. And easy.

Two instruments in one.

The 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. Push the "Reset to Local" button and the 492P becomes a 492—with operation from the front panel. But, most important, the 492P opens the way to automated spectrum analysis and documentation via its IEEE-488 (GPIB) interface.

This versatility makes the 492P useful in many applications in the lab, factory or field.

When used with the Tektronix 4052 Graphic Computing System controller and 4631 Hard Copy Unit, or with the 4662 Digital Plotter, the 492P can provide test results in both graphic and numeric form for the evaluation of microwave signal sources.

With or without a controller.

Switches on the rear panel select the mode of operation as a GPIB instrument. In the normal TALKER/LISTENER mode, the 492P listens to and executes commands from a GPIB controller. All important front panel settings can be operated remotely. Some functions are controlled with more detail through the bus than possible from the front panel.

Easy to use.

The 492P is designed for ease of operation via the GPIB, just as the 492 is designed for front panel operational ease. Most commands for program control are simply abbreviations of the front panel nomenclature.

The 492P's high level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

Put it to work.

With the programmable 492P on your measurement team, repetitive measurements can be done the same way every time. Your throughput will increase—and your confidence in results. And, the internal processing and high level programming language makes software development faster. You get high power results with easy programming. When you look at the total performance capability of the 492P, you'll recognize its value: Ease of operation both as a programmable and manual instrument. Wide frequency range. The versatility to go where you go. Into the lab for automated testing; into the field for data collection.

SPECIFICATIONS

FREQUENCY RELATED

Frequency Range — 50 kHz to 21 GHz with internal mixer, to 220 GHz with external mixers. Option 08 deletes coverage above 21 GHz (calibrated mixers to 60 GHz available from Tektronix).

Frequency Accuracy — ±0.2% or 5 MHz whichever is greater +20% of span/div.

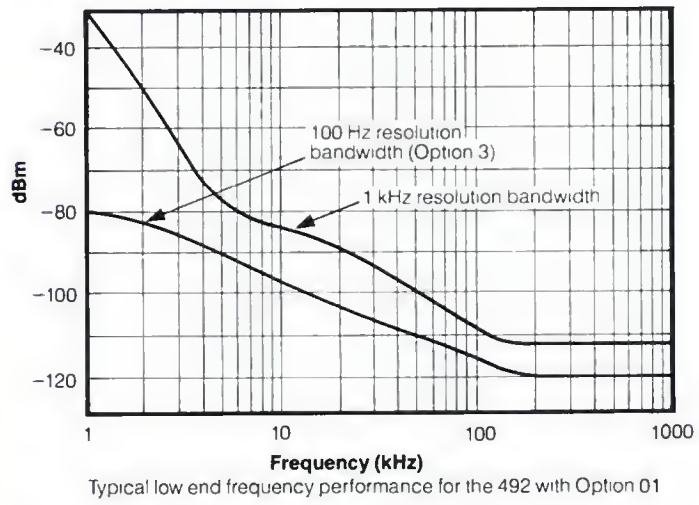
Frequency Readout Resolution — Within 1 MHz.

Frequency Span per Division — 10 kHz to 500 MHz plus zero and full band max span, down to 500 Hz with Opt. 03—in 1-2-5 sequence.

Frequency Span Accuracy — ±5% of span/div, measured over center eight divisions.

Resolution Bandwidth @ 6 dB Points — 1 MHz to 1 kHz (100 Hz for Option 03) in decade steps within ±20%, manually or automatically selected.

Resolution Shape Factor (60/6 dB) — 7.5; maximum.



Typical low end frequency performance for the 492 with Option 01

Figure 1

SPURIOUS RESPONSES

Residual (no input signal) — −100 dBm or less referenced to input mixer for fundamental conversion.

Harmonics — At least −60 dBc for full screen signal in the Min Distortion mode to 21 GHz. At least −100 dBc for preselected Option 01. 1.7 to 21 GHz.

Intermodulation — 3rd order products at least −70 dB down from two full screen signals within any frequency span in the Min Distortion mode. At least −100 dB down for two signals spaced more than 100 MHz apart from 1.7 to 21 GHz for preselected Option 01.

L.O. Emissions (referenced to input mixer) — −10 dBm maximum; −70 dBm maximum for Option 01.

STABILITY
(after 2 hour warm-up)

Residual FM — (1 kHz p-p) n (mixing number) for 20 ms time duration, improves to (50 Hz) n for 20 ms with phaselock Option 03.

Long Term Drift: 200 kHz/hour unphaselocked, 25 kHz/hour phaselocked for fundamental mixing.

Noise Sidebands — At least 75 dBc @ 30X resolution offset (70 dBc for 1 kHz resolution) for fundamental mixing.

AMPLITUDE RELATED

Reference Level Range — −123 dBm to +40 dBm (+30 dBm maximum safe input) for 10 dB/div and 2 dB/div log modes. 20 nV/div to 2 V/div (1 W maximum safe input) in the linear mode.

Reference Level Steps — 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in log mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.

Reference Level Accuracy — Amplitude change of 0.25 dB ±0.05 dB, 1 dB ±0.2 dB, 10 dB ±0.5 dB; to a maximum of ±1.4 dB for 60 dB and ±2 dB for 90 dB reference level change when gain change and attenuation do not offset each other.

Display Dynamic Range — 80 dB @ 10 dB/div, 16 dB @ 2 dB/div and 8 divisions linear.

Display Amplitude Accuracy — ±1 dB/10 dB to maximum of ±2 dB/80 dB; ±0.4 dB/2 dB to maximum of ±1 dB/16 dB; ±5% of full screen in LIN mode.

Resolution Bandwidth Gain Variation — ±0.5 dB.

50 kHz to 220 GHz Compact Spectrum Analyzers

SENSITIVITY AND FREQUENCY RESPONSE

Frequency Range	Mixing Number (n)	Average Noise Level for 1 kHz Resolution		Frequency Response With 10 dB Attenuation	
		No Preselection	Preselected Option 01	No Preselection	Preselected Option 01
50 kHz-1.8 GHz*	1	−115 dBm	−110 dBm		±1.5 dB
50 kHz-4.2 GHz*	1	−115 dBm	−110 dBm	±2.5dB	
1.7-5.5 GHz	1	−115 dBm	−110 dBm	±1.5 dB	±2.5 dB
3.0-7.1 GHz	1	−115 dBm	−110 dBm	±1.5 dB	±2.5 dB
5.4-18 GHz	3	−100 dBm	−95 dBm (12 GHz) −90 dBm (18 GHz)	±2.5 dB	±3.5 dB
15-21 GHz	3	−95 dBm	−85 dBm	±3.5 dB	±5.0 dB**
100 MHz-18 GHz***				±3.5 dB	±4.5 dB
With Tektronix optional high performance waveguide mixers					
18-26 GHz	6	−100 dBm		±3 dB	
26-40 GHz	10	−95 dBm		±3 dB	
40-60 GHz	10	−95 dBm		±3 dB	

*Low frequency end performance does not include effects due to zero Hz feedthrough.

** Flatness and accuracy specifications do not apply to the 30, 40, 50, and 60 dB *rf* attenuator positions between 19 and 20 GHz.

*** Includes frequency band switching error of 1 dB maximum.

INPUT CHARACTERISTICS

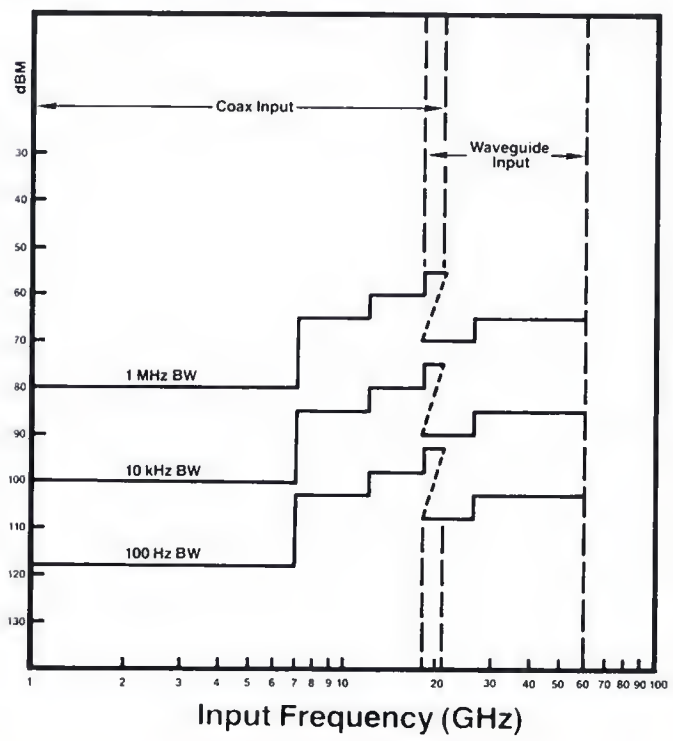
Internal Mixer — Type N female connector, VSWR 1.45 to 18 GHz, and 3.5 to 21 GHz; with 10 dB or more attenuation.

Optimum Level for Linear Operation — −30 dBm referenced to mixer.

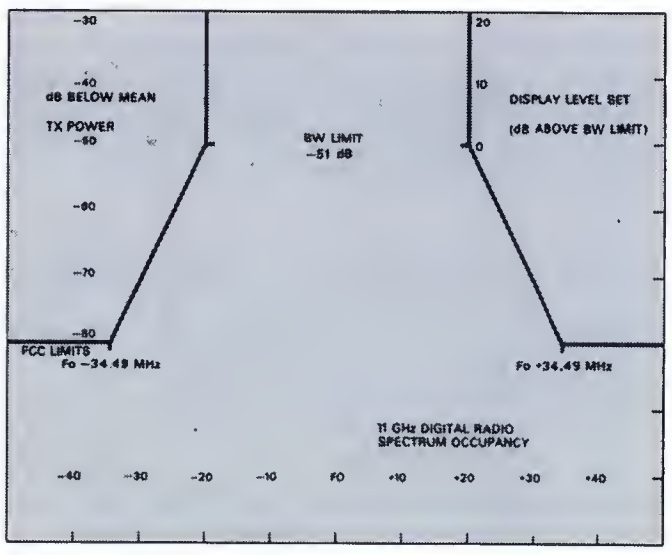
1 dB Compression Point — −28 dBm from 1.7 to 2 GHz for Option 01; otherwise −10 dBm.

Maximum Safe Input Level — +13 dBm without Option 01, +30 dBm (1 watt) with Option 01, zero rf attenuation.

Attenuator Power Limit — +30 dBm (1 w) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor.



Input Frequency (GHz)



CRT mask for digital radio application. Ask about the modified 492 optimized for digital radio measurements.

OUTPUT CHARACTERISTICS

Calibrator — −20 dBm ±0.3 dB, 100 MHz ±.01%.

1st LO — +7.5 dBm @ 50 Ω nominal +15 dBm max.

2nd LO — −16 dBm @ 50 Ω nominal +15 dBm max.

Vertical Out — 0.5 V ±5%/division, 1 kΩ nominal.

Horizontal Out — 0.5 V ±10%/division, 1 kΩ nominal.

Pen Lift — TTL, 5 V nominal.

IF Out — −15 dBm nominal for full screen, −30 dBm display; 10 MHz, 50 Ω.

GPIB Control — IEEE 488 input/output control for 492P.

MISCELLANEOUS

Sweep Time — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

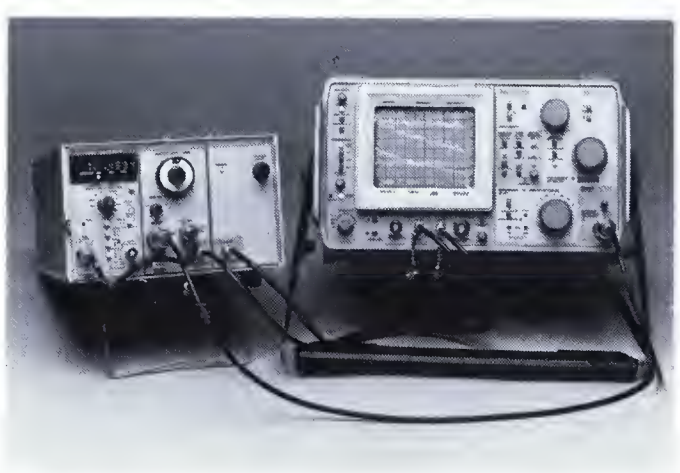
CRT Readout — Reference level, center frequency, frequency range, vertical display mode, frequency span/div, resolution bandwidth, and rf attenuation.

CRT — 8x10 cm, P31 Phosphor.

Power — 90 to 132 VAC, 180 to 250 VAC, 48 to 440 Hz, 210 W max with all options.

Environmental Characteristics — Per MIL-T-28800B type III, class 3, style C.

Configuration — Portable, 44 lb (all options), 6.9 x 12.9 x 19.7 inches without handle or cover.



The 492/TR 503 provides a constant level calibrated rf source for swept frequency tests from 100 kHz to 1.8 GHz.

50 Hz system stability enhances high "Q" filter analysis.

ORDERING INFORMATION

492 Spectrum Analyzer **$19,250**

492P Spectrum Analyzer **$24,250**

Option 01—Internal Preselection . . . . . **Add $3900**
Provides calibrated preselected filtering of first mixer for each frequency band.

Option 02—Digital Storage . . . . . **Add $1800**
Provides multiple memory display storage with Save A, Max Hold, B Minus Save A, display averaging, and storage bypass.

Option 03—Frequency Stabilization/ 100 Hz Resolution . . . . . **Add $3500**
Provides first local oscillator stabilization by phase locking the oscillator to an internal reference. Also provides 100 Hz resolution.

Option 08—Delete External Mixer Capability Sub $1750
Deletes external mixer capability which provides internal switching and connection capability to connect and use external waveguide mixers.

Option 20—General Purpose 12.4 to 40 GHz Waveguide Mixer Set . . . . . **Add $520**
Includes three mixers (12.4 to 18 GHz, 18 to 26.5 GHz, and 26.5 to 40 GHz) and attaching hardware to extend the upper frequency.

Option 21—High Performance 18 to 40 GHz Waveguide Mixer Set . . . . . **Add $1970**
Includes two mixers (18 to 26.5 GHz and 26.5 to 40 GHz) and attaching hardware to extend the upper frequency.

Option 22—High Performance 18 to 60 GHz Waveguide Mixer Set **$3220**
Includes three mixers (18 to 26.5 GHz, 26.5 to 40 GHz, and 40 to 60 GHz) and attaching hardware to extend the upper frequency.

INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 Universal Euro 220V/16A . . . . . **No Charge**

Option A2 UK 240V/13A . . . . . **No Charge**

Option A3 Australian 240V/10A . . . . . **No Charge**

Option A4 North American 240V/15A . . . . . **No Charge**

PERIPHERAL PRODUCTS FOR 492P SPECTRUM ANALYZER

4052 Graphic Computing System Controller . . **$10,950**

4631 Hard Copy Unit **$4,950**

4662 Interactive Digital Plotter **$4,600**

4924 Digital Cartridge Tape Drive **$2,695**

OPTIONAL ACCESSORIES

The following listed accessories are optional to all models and configurations of the 492 system, and may be ordered in any combination.

General Purpose 12.5 to 40 GHz Waveguide Mixer Set (016-0640-00) **$615**

1405 TV Sideband Adapter **$4,160**

TR 503 Tracking Generator **$6300**
For more information on the TR 503 see page 246.

High Performance 18 to 40 GHz Waveguide Mixer Set (016-0662-00) **$2005**

High Performance 18 to 60 GHz Waveguide Mixer Set (016-0657-00) **$3255**

Hard Case (transit) (016-0658-00) **$625**

Soft Case (016-0659-00) **$125**

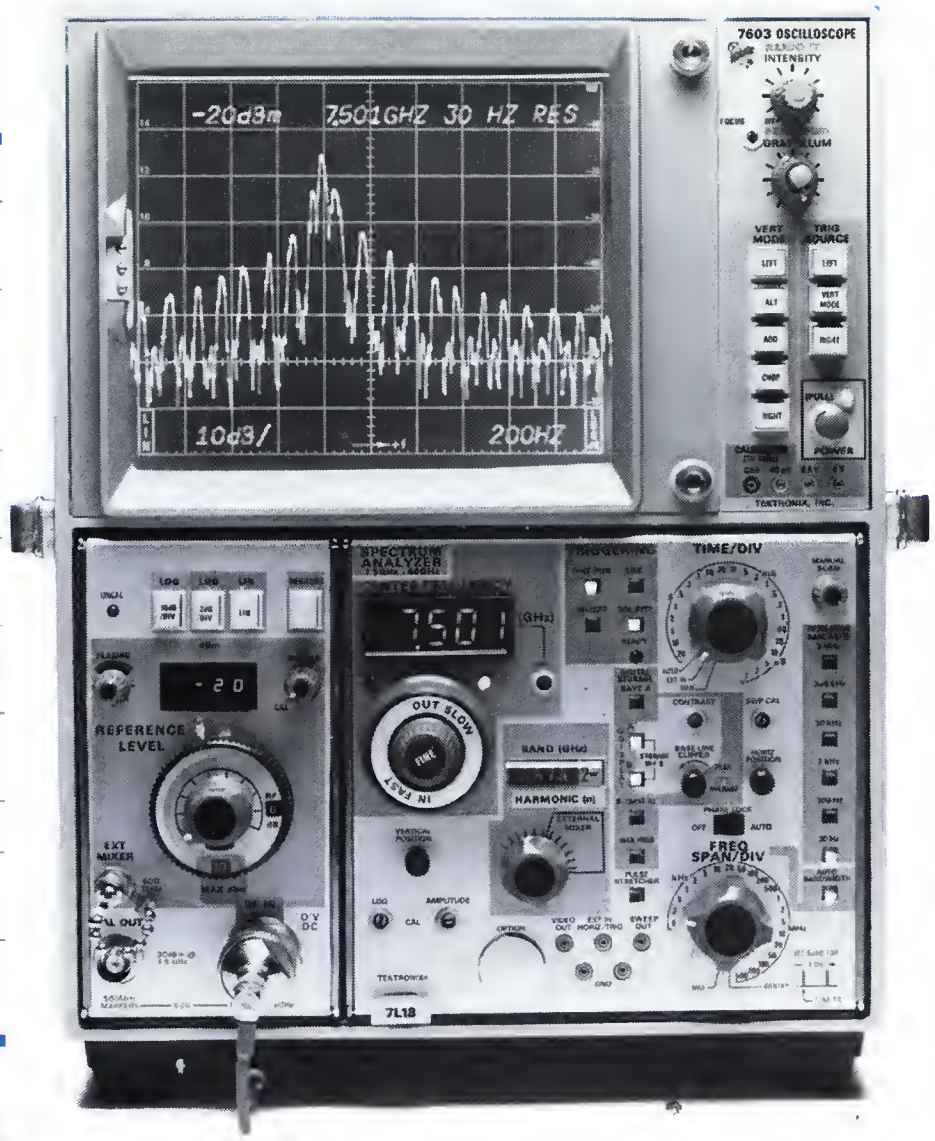
C-5C Camera **$425**

Note: The 492 Spectrum Analyzer system is compatible with all TEKTRONIX C-50 Series Cameras.

1.5 GHz to 60 GHz Plug-in Spectrum Analyzer

7L18

- 30 Hz Resolution to 12 GHz
- Microprocessor-aided Front Panel Controls
- Digital Display and Signal Processing (Max Hold, Save A, Split and Comparison Features, and Algebraic Addition)
- Calibrated Reference Level Includes Internal Preselector
- 60 GHz with Optional Waveguide Mixers
- Transportable—Just 48 Pounds Including 7603 Mainframe
- Preselected for Freedom from Spurious Responses
- 80 dB Display Dynamic Range
- ≤ 10 Hz Residual FM (Fundamental Mixing)
- Fits all 7000 Series Mainframes including USM-281C



7L18 SPECIFICATIONS

FREQUENCY RELATED

Frequency Range—1.5 GHz to 60 GHz

Tuning Range—
With internal mixer: 1.5 GHz to 18 GHz.
With external mixer: 12.5 GHz to 60 GHz.

Frequency Span—Per Division: 20 calibrated span width from 200 Hz/div to 500 MHz/div in a 1-2-5 sequence. Max span: Depends on mixing mode. Span widths=N x 2 GHz where N is the mixing mode. Maximum span full screen is 8.5 GHz with internal mixer (9.5 to 18 GHz band). Zero Span: Non-sweeping tunable receiver mode.

Tracking Preselector—Internal and automatic 1.5 to 18 GHz. Rejection of harmonic mixing, image and multiple responses > 70 dB.

Frequency Bands—

With internal mixer	(N = mixing mode)
1.5 GHz to 3.5 GHz	N = 1−
2.5 GHz to 4.5 GHz	N = 1+
3.5 GHz to 7.5 GHz	N = 2−
6.5 GHz to 12.5 GHz	N = 3+
9.5 GHz to 18.0 GHz	N = 5−
With external mixer	(N = mixing mode)
12.5 GHz to 24.5 GHz	N = 6+
14.5 GHz to 28.5 GHz	N = 7+
16.5 GHz to 32.5 GHz	N = 8+
18.5 GHz to 36.5 GHz	N = 9+
20.5 GHz to 40.5 GHz	N = 10+
30.5 GHz to 60 GHz	N = 15+

Frequency Accuracy—
Dial Accuracy: (5 MHz +20% of frequency span/div) x N [typically (1 MHz)x N with degauss activated].

Span accuracy—5% over center 8 horizontal divisions (typically 3%).

Stability—Residual fm stabilized 10 Hz peak-to-peak x N (typically 2 Hz peak-to-peak x N).

Frequency Drift—
Long term drift: (at fixed center frequency after 2 hr warm up).
Stabilized: 2 kHz/hr x N.
Unstabilized: 50 kHz/hr x N.

Setability—
Within 1 MHz for 1.5 GHz to 18 GHz (after 2 hr warm up).
Within 10 MHz with external mixers (after 2 hr warm up).

Resolution—
Bandwidth range: Selectable 6 dB bandwidths from 30 Hz to 3 MHz in decade steps plus auto.
Shape factor: 4:1, 60 dB to 6 dB points, 300 Hz to 3 MHz, 12:1, 60 dB to 6 dB points, 30 Hz.
Bandwidth accuracy: 6 dB points, 20%.

Phase Noise Sidebands—When phase locked, for fundamental (N=1) conversion: −70 dBc min at frequency offsets ≥20X resolution bandwidth settings.

Table 1

Sensitivity and Frequency Response with Internal Mixers—(Average noise level specified for 300 Hz resolution bandwidth. Frequency Response with 10 dB input attenuator setting.)

Frequency Range (GHz)	Mixing Mode	Average Noise Level (dBm Max)	*Frequency Response Optimum Peaking (dB Max)
1.5—3.5	1−	−119	±1.5
2.5—4.5	1+	−119	±1.5
3.5—7.5	2−	−109	±2.0
6.5—12.5	3+	−107	±2.5
9.5—18.0	5−	−92	±3.0

*Includes mixer frequency response, rf attenator frequency response, internal preselector frequency response, mixing mode gain variation, rf input vswr.

Table 2

Sensitivity and Frequency Response with External Mixers—Average noise level specified for 3 kHz resolution bandwidth.)

Frequency Range (GHz)	Mixing Mode	Average Noise Level (dBm Max)	Frequency Response (dB Max)
12.5—18.0	6+	−85	—
**18.0—26.5	7+	−90	±3
**26.5—40	10+	−85	±3
**40—60	15+	−75	±3

**High Performance Mixer Line.

AMPLITUDE RELATED

MEASUREMENT RANGE

Log Reference Level— −110 dBm to +40 dBm (+30 dBm max safe input level).

Log Display Dynamic Range—80 dB.

Linear—8 divisions with calibrated reference levels.

Rf Attenuation Range—6 steps @ 10 dB/step.

If Gain Range—9 steps @ 10 dB/step −20 dBm to −110 dBm (with zero rf attenuation) (−20 dBm is reduced noise position).

Sensitivity and Frequency Response—See Tables 1 and 2.

Amplitude Accuracy—
If gain variation with different resolution bandwidths (at 25°C).
Log: ±0.5 dB.
Reference level variation due to band switching: ±1.0 dB.
Display—
Log 10 dB/div: ±1.0 dB/10dB to a maximum of 2.0 dB. Log 2 dB/div: ±0.4 dB/2 dB to a maximum of 1.0 dB.
Linear: ±10%.
If gain: ±1.0 dB/10 dB, ±2 dB max.
Rf attenuator: ±0.3 dB/10 dB to a maximum of ±0.7 dB.

Calibrator output: Amplitude −30 dBm ±0.5 dB, frequency 2.0 GHz ±0.01%.
Absolute Calibration Accuracy 1.5 to 18 GHz. Overall accuracy is a function of measurement technique and includes the following parameters: Amplitude calibrator + band switching error + if gain switching + rf attenuator switching + logging error + flatness + digital quantizing error (if digital storage is used). With appropriate technique, absolute accuracy of ±2.5 dB is usually achievable (1.5 to 18 GHz).

INPUT CHARACTERISTICS

Input Impedance—50 Ω nominal (1.5 to 18 GHz).
Connector—Type "N" female.
Vswr—≤1.35 for attenuator settings of ≥10 dB.
Maximum Input Level—1 watt (+30 dBm).
Optimum Input Level—≤ −30 dBm with zero rf attenuation.
Input Compression Point—≥ −28 dBm from 1.5 to 1.8 GHz. ≥ −18 dBm from 1.8 to 18 GHz (both with zero rf attenuation.)
L.O. Emission—−80 dBm, 1.5 to 18 GHz (10 dB input attenuator setting).

SPURIOUS RESPONSES

Residual—(No signal present at input) with input attenuation at 0 dB, ≤ −110 dBm.
Intermodulation Distortion—Third order down 70 dB or more from any two full screen signals, when if gain is not set to red zone (reduced noise position).
Mixed—All harmonic mixing, image and multiple responses down 70 dBc to 18 GHz.

DIGITAL STORAGE AND SIGNAL PROCESSING

Multiple memory display storage (A & B memory).
Save "A".
Digital display averaging.
Max hold.
B minus "Save A".
Disable for non-storage viewing.

GENERAL

Sweep Characteristics—1 μs/div to 20 sec/div in a 1, 2, 5 sequence plus auto, manual, and external. Accuracy ±5%.
Triggering Modes—Internal, external, free run, single sweep. Triggering source line, internal, external. Sensitivity: 1 div internal, 0.5 volt external (50 volts max). Frequency Range: 15 Hz to 1 MHz.
Video Output—500 mV ±5%/div of display.
Pulse Stretcher—Enhances pulsed rf measurements.
Degauss—Improves frequency measurement accuracy.
X, Y Output—Front panel pin jacks.
Uncal Light—Provides indication of uncalibrated display amplitude.
Peaking—Optimizes sensitivity and frequency response.

ACCESSORIES

Included—	Part Number
1 Spectrum Analyzer Graticule	337-1439-01
1 Spectrum Analyzer Graticule	337-1159-02
1 50 Ω coaxial cable, 10 in.	012-0208-00
1 Adapter, BNC female to N male	103-0045-00
Plug-in to Mainframe Securing Kit	016-0637-00

Optional—

General Purpose Waveguide Mixers

Set	**016-0640-00**	**$615**
Mixer	**119-0097-01** 12.4 to 18 GHz	**130**
Mixer	**119-0098-01** 18 to 26.5 GHz	**170**
Mixer	**119-0099-01** 26.5 to 40 GHz	**200**
Cable	**012-0748-00**	**20**
Case	**004-1651-00**	**35**

High Performance Waveguide Mixers

Set	**016-0657-00**	**$3255**
Mixer	**016-0631-01** 18 to 26.5 GHz	**975**
Mixer	**016-0632-01** 26.5 to 40 GHz	**975**
Mixer	**016-0634-01** 40 to 60 GHz	**1250**
Cable	**012-0649-00**	**25**
Case	**004-1651-00**	**35**

Carrying Case: Protective aluminum case with hinged latchable front cover and carrying handle.
016-0625-00 ..... **$195**

ORDERING INFORMATION

7L18 Spectrum Analyzer **$16,950**
***7603 Oscilloscope** **$2555**
R7603 Oscilloscope (Rackmount) **$2955**
Option 06 Internal S A Graticule ..... **Add $50**
Option 08 Protective Front Cover (Cabinet Only) ..... **Add $100**

*Suggested Mainframe: 7603 Opt 08/Opt 06 for maximum transportability. Has protective front cover (Opt 08) and Spectrum Analyzer Graticule (Opt 06). See 7000 Series pages for oscilloscope specifications and options.

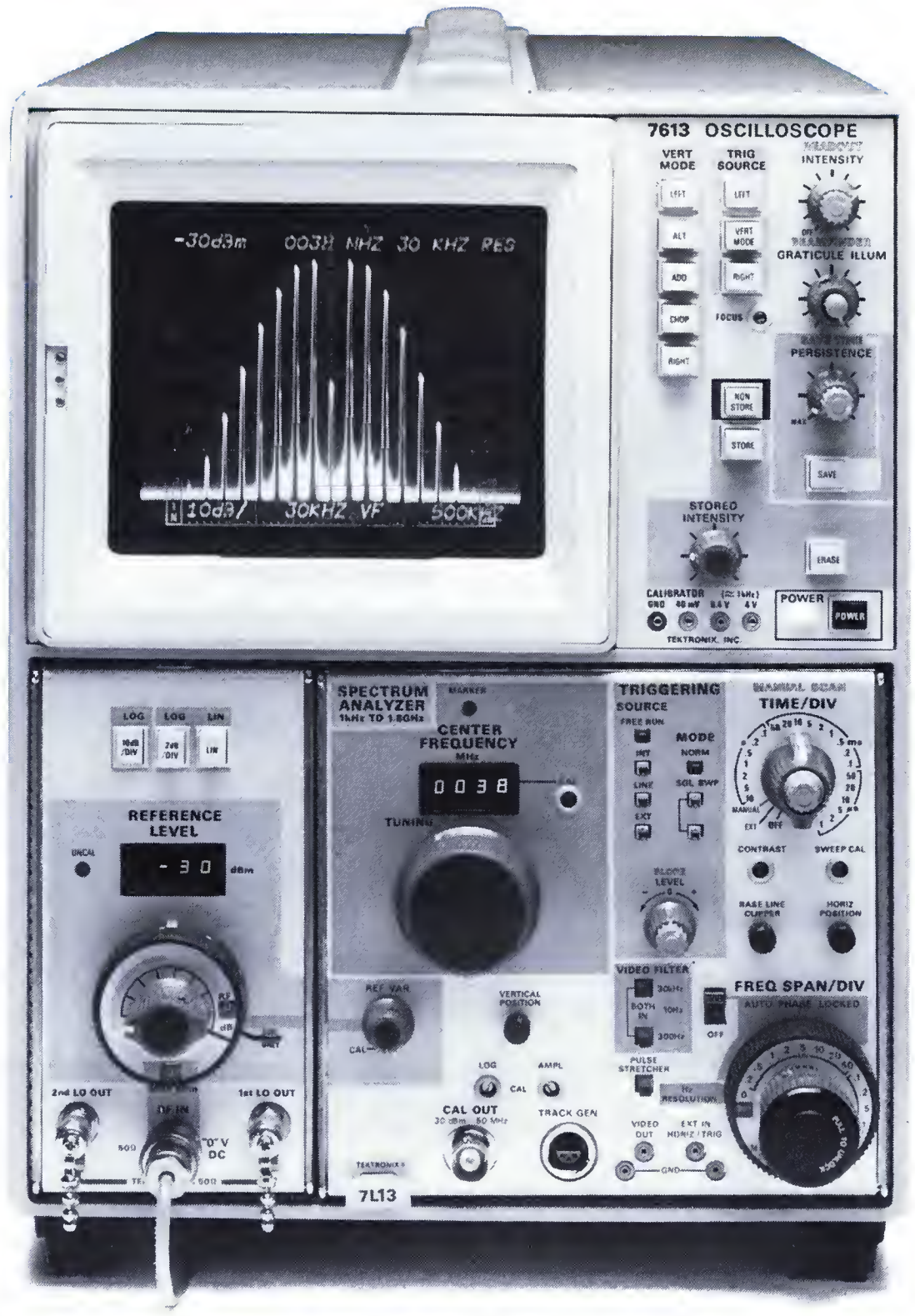
1 kHz to 1800 MHz Plug-in Spectrum Analyzer

7L13

- 1 kHz to 1800 MHz in One Display
- Fully Calibrated Displays
- 30 Hz to 3 MHz Resolution
- 4:1 Resolution Bandwidth Shape Factor
- 70 dB On-screen Dynamic Range
- IM Distortion 70 dB below Full Screen
- Spurious Free Operation
- Automatic Phase Lock
- −128 dBm Sensitivity

The 7L13 Spectrum Analyzer represents the highest performance possible today in an instrument of this frequency range and price. The fm stability is 10 Hz, making 30 Hz resolution possible across the entire frequency range.

This analyzer is a high quality laboratory instrument. In addition to incorporating the standard features of the 7L12, it has CRT readout of the center frequency, and an UNCAL light to indicate incorrect settings of the sweep rate or resolution controls.



The 2.5 GHz modified 7L13 in a 7613 Mainframe featuring variable persistence. Variable persistence is recommended for maximum utilization of the capabilities of the 7L13. Information is available upon request.

7L13 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 1 kHz to 1.8 GHz.

Resolution Bandwidth — Resolution bandwidth selections from 30 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 12:1 or better for 30 Hz resolution and 4:1 or better for 300 Hz to 3 MHz resolution.

Stability — Within 2 kHz, after a 2 hour warm-up, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temeprature.

Incidental Fm — 10 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from −110 dBm to +30 dBm, within ±2 dB. An UNCAL indicator shows when excessive sweep speeds are selected.

Log 10 dB/div:
−70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
−14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode) −128 dBm at 30 Hz, −115 dBm at 300 Hz, −108 dBm at 3 kHz, −100 dBm at 30 kHz, −90 dBm at 0.3 MHz, −80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — +1 dB, −2 dB over any frequency span.

Spurious Responses —
Residual — (No signal present at input) with input attenuation at 0 dB, ≤− 100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.

Mixed — All image, harmonic related, and out-of-band mixing responses are ≥70 dB down from a level of −30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 80 dB when operating with 30 Hz resolution bandwidth. 70 dB with 300 Hz to 3 MHz resolution bandwidth. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — Calibrated steps in 1-2-5 sequence from 200 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — Selection of an external sweep source, manual sweep, or calibrated time base, 10 s/div to 1 μs/div.

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, −30 dBm at 50 Ω.

Video Out — Approx 2 V full screen.

Horiz In — (and Trig) For use with chart recorder.

Tracking Gen (Logic) — For use with tracking generator (5 V TTL).

1st LO — For use with tracking generator or 1405 Sideband Adapter.

2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, 337-1439-01 for 7403N and 7603 Oscilloscope and 337-1159-02 for other 7000 Series Oscilloscopes. Amber Light Filter, 378-0684-01; 50 Ω Coaxial Cable, with BNC connectors, 6 foot, 012-0113-00; BNC Male to N Female Adapter, 103-0058-00.

ORDERING INFORMATION

7L13 Spectrum Analyzer **$10,500**

7603 Mainframe **$2260**

Option 08 Protective Front Cover ..... **Add $100**

Option 77 P7 Phosphor and Internal S A Graticule ..... **Add $35**

7613 Variable Persistence Mainframe **$3620**

Option 06 Internal S A Graticule ..... **Add $50**

Option 08 Protective Front Cover ..... **Add $100**

Extended Frequency Range to 2.5 GHz. Ask about the modified 7L13.

100 kHz to 1800 MHz Plug-in Spectrum Analyzer

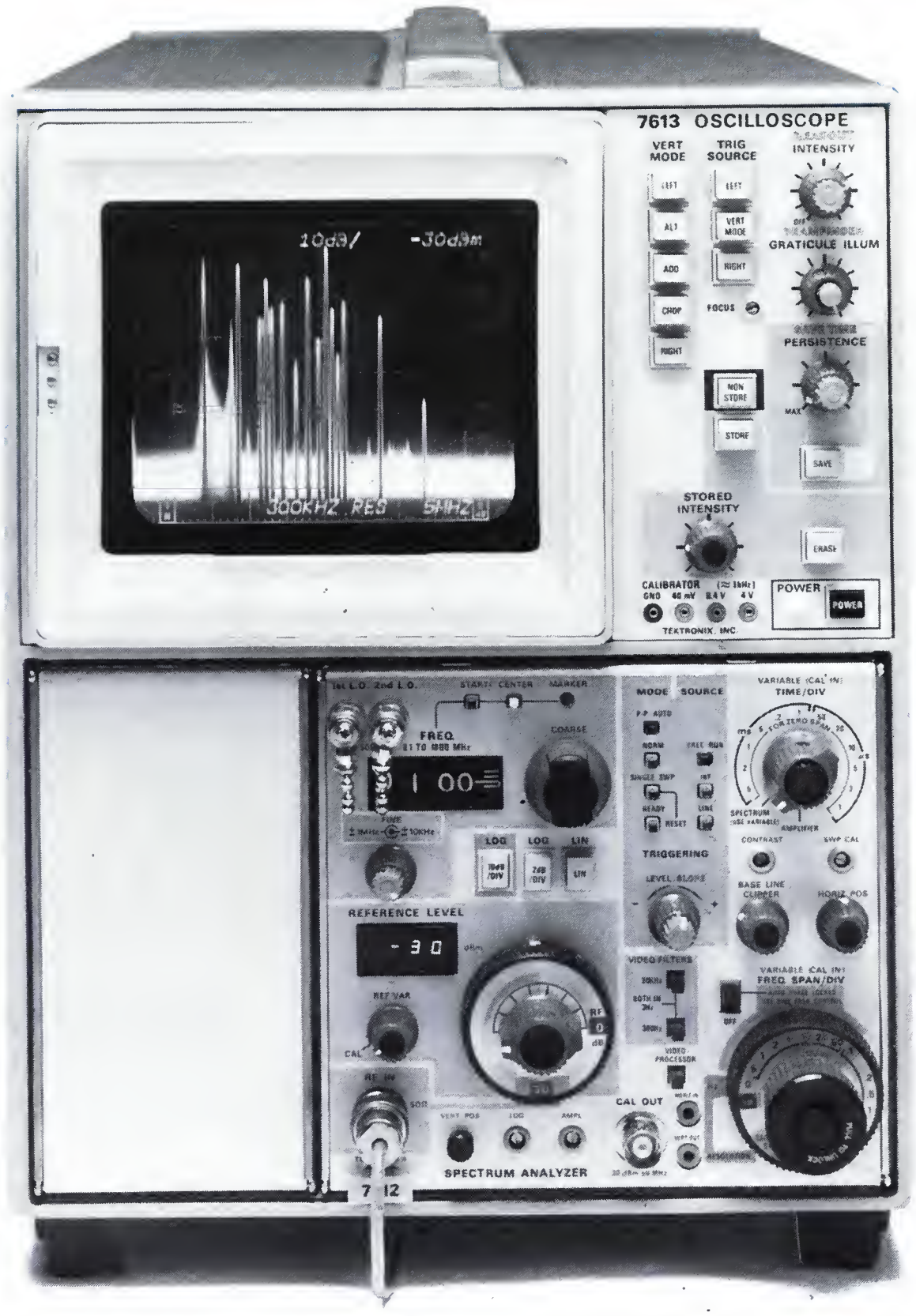
7L12

- 100 kHz to 1800 MHz in One Display
- Fully Calibrated Displays
- 300 Hz to 3 MHz Resolution
- 4:1 Resolution Bandwidth Shape Factor
- 70 dB On-screen Dynamic Range
- IM Distortion 70 dB below Full Screen
- Spurious Free Operation
- Automatic Phase Lock
- −115 dBm Sensitivity

The 7L12 Spectrum Analyzer is a modern, high-performance, swept front-end type of analyzer covering the frequency range up to 1.8 GHz. The unit employs phase lock stability and an ample selection of resolution bandwidths in an economical field or laboratory instrument.

The unit has a 3 MHz resolution mode for accurate measurement of pulse phenomena; the zero-span mode may be used to present a demodulated display of a signal for time domain measurements. A 4:1 resolution bandwidth shape filter introduced by Tektronix permits close-in measurements not possible with conventional filters. Noise measurements are also easily made due to the high sensitivity, video filters, and equivalent resolution and noise power bandwidth of the instrument.

The 7L12 fills two holes in any 3- or 4-hole 7000 Series Mainframe and features a complete time base so that other oscilloscope or time domain plug-ins may be used simultaneously. As with all 7000 Series Plug-ins, CRT READOUT will display the major parameters. For the 7L12, these include: reference level, dB/div, frequency span and resolution.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.

7L12 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 100 kHz to 1.8 GHz. (Usable below 100 kHz with degraded performance.)

Resolution Bandwidth — Resolution bandwidth selections from 300 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 4:1 or better.

Stability — Within 50 kHz, after 2 hour warm-up, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — 200 Hz (p-p) max when phase locked. 20 kHz (p-p) when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from −100 dBm to +30 dBm, within ±2 dB.

Log 10 dB/div:
−70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
−14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode). −115 dBm at 300 Hz, −108 dBm at 3 kHz, −100 dBm at 30 kHz, −90 dBm at 0.3 MHz, −80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — ±1.5 dB over any frequency span.

Spurious Responses —
Residual — (No signal present at input) with input attenuation at 0 dB, ≤−100 dBm.
Intermodulation Distortion — Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.
Mixed — All image, harmonic related, and out-of-band mixing responses are ≥70 dB down from a level of −30 dBm to the input mixer (0 dB input attenuation).
Dynamic Range — 70 dB. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — 500 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — 10 ms/div to 1 μs/div.

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, −30 dBm at 50 Ω.
Vert Out — Approx 2 V full screen.
Horiz In — For use with chart recorder.
1st LO — For use with tracking generator or 1405 Sideband Adapter.
2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, 337-1439-01 for 7403N and 7603 Oscilloscopes and 337-1159-02 for other 7000 Series Oscilloscopes. Amber Light Filter: 378-0684-01; Light Filter: 378-0625-07; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

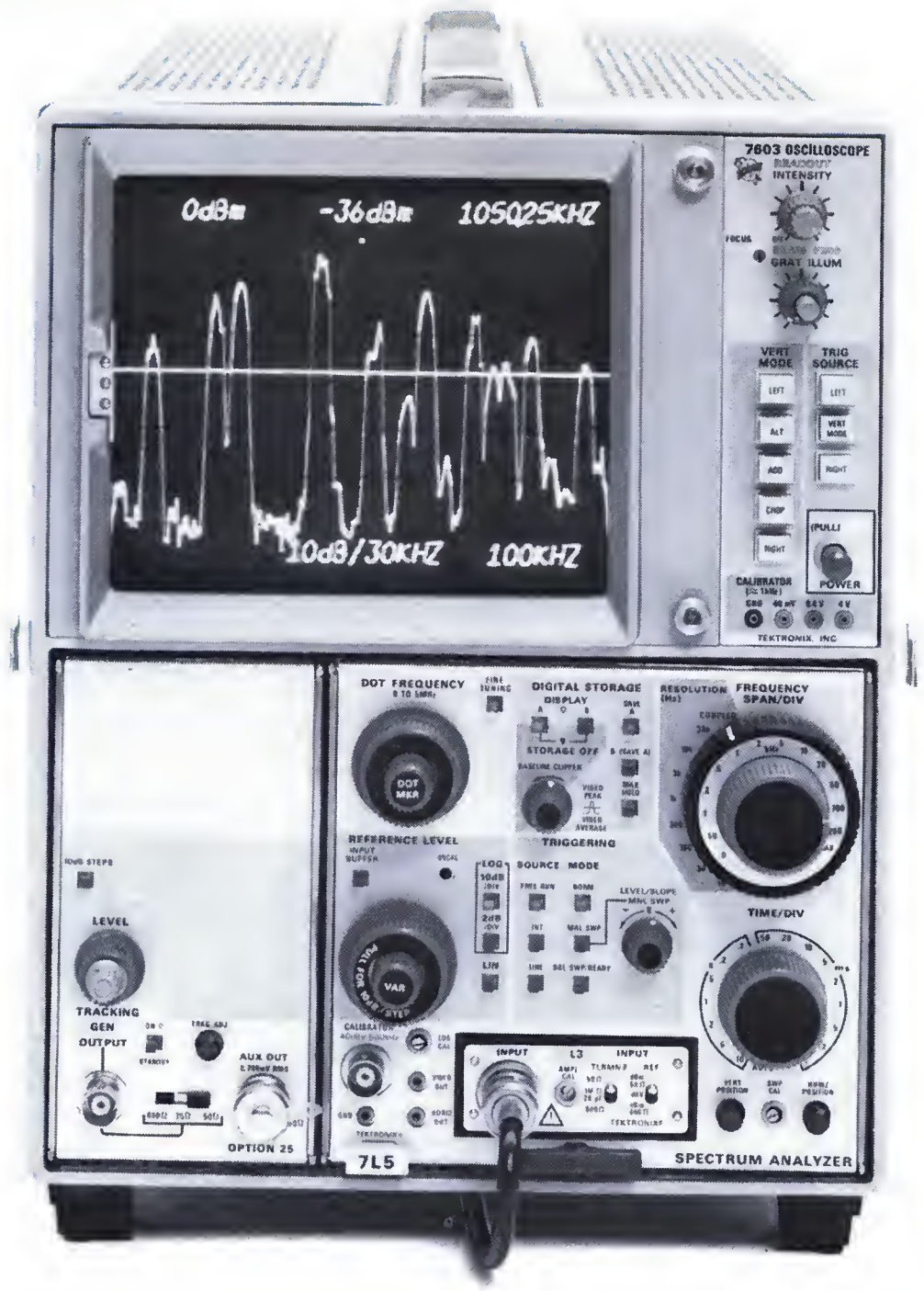
7L12 Spectrum Analyzer **$7500**
7603 Mainframe **$2555**
Option 08 Protective Front Cover ..... **Add $100**
Option 77 P7 Phosphor and Internal S A Graticule ..... **Add $35**
7613 Variable Persistence Mainframe **$4395**
Option 06 Internal S A Graticule ..... **Add $50**
Option 08 Protective Front Cover ..... **Add $100**
7K11 CATV Preamplifier **$830**

Extended Frequency Range to 2.5 GHz. Ask about the modified 7L12.

20 Hz to 5 MHz Plug-in Spectrum Analyzer

7L5

- Three-knob Operation
- Synthesizer Stability for six-digit accuracy of center frequency setting
- Improved Digital Storage & Averaging
- Reference Level Selection in 1 dB Steps
- Absolute Calibration in dBm, dBV or Volts/Div
- Tracking Generator Option for Swept Component Measurements
- Changeable Input Impedance Modules to accommodate any Impedance Requirement
- Wide Dynamic Range and Nanovolt Sensitivity
- Preset Reference Level for extra Input Protection
- CRT Readout of all Major Parameters
- New B Minus "Save A" Feature



7L5 Option 25 Spectrum Analyzer with L3 Plug-in Module in a 7603 Option 06 Mainframe with internal spectrum analyzer graticule.

The 7L5 is an audio/baseband spectrum analyzer plug-in that provides exceptional frequency accuracy and operator convenience through a combination of frequency synthesizer and digital technology.

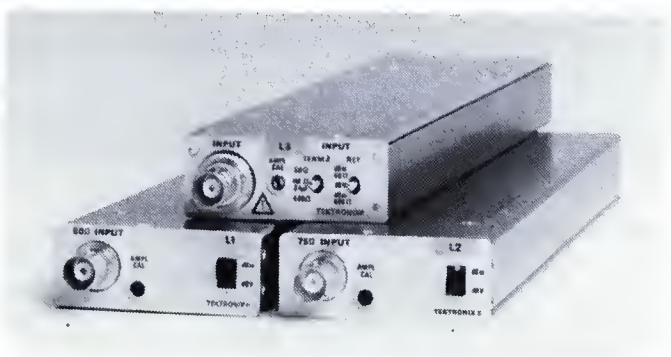
The center frequency can be set with six digit accuracy immediately after turn-on. A built-in micro-computer decodes control settings, processes frequency span and reference level information and optimizes sweep time and resolution for the span chosen.

To accommodate a wide variety of user preferences, the 7L5 uses changeable plug-in input modules providing a variety of input impedances such as 50, 75, 600, or 1 megohm. The built-in computer automatically adjusts the calibrator to provide the correct reference level for the impedance chosen.

Digital storage, in addition to providing clean, easy-to-interpret displays, also makes such special functions as digital averaging and peak detection possible. The display is stored electronically and updated during each sweep. Two complete displays can be held in memory for comparison. A max hold function stores the maximum signal level over long periods of time to measure amplitude and frequency drift.

CRT readout displays the center frequency, reference level, resolution bandwidth, dB per division and frequency span.

The new B minus "Save A" provides algebraic subtraction of two traces, so that changes in multi-signal spectrums can be monitored.



Changeable modules permit the 7L5 user to adapt to new measurement requirements. Modules now available are the 50 Ω L1, 75 Ω L2, 1 MΩ L3, and the L1-GC. The probe-compatible L3 offers selectable internal 50 Ω, 1 MΩ, or 600 Ω impedance, while the L3-1 offers 75 Ω, 1 MΩ or 600 Ω. The module you select calibrates displays for the impedance in use. The L1-GC module (not shown) covers if frequencies of 21.4 MHz and 10.7 MHz plus the normal 20 Hz to 5 MHz frequency range.

7L5 CHARACTERISTICS

The folowing characteristics and features apply to the 7L5 Spectrum Analyzer and its options. They are applicable over the environmental specification criteria for the 7000 Series Mainframes.

FREQUENCY CHARACTERISTICS

Range — Input frequency range is 20 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 250 Hz steps. Dot accuracy: 0°C to 50°C ±(20 Hz + 10^{-5} of dot frequency); 20°C to 30°C ±(5 Hz + 2X 10^{-6} of dot frequency).

Drift — Frequency drift is ≤5 Hz/hour.

Residual Incidental Fm — Residual fm is ≤ 1 Hz (p-p) for frequency spans of 50 Hz/div to 2 kHz/div. Residual fm is ≤ 40 Hz (p-p) for frequency spans of 5 kHz/div to 500 kHz/div.

Resolution Bandwidth — 8 resolution bandwidths range from 30 kHz to 10 Hz. COUPLED switch position electronically couples resolution to span/div selection so that both are controlled by the same knob. Bandwidth accuracy @ 6 dB down is within 20% of selected resolution. Shape factor (60:6 dB ratio) is 10:1 or better for 10 Hz to 1 kHz and 5:1 or better from 3 kHz to 30 kHz. Amplitude change between resolution bandwidths is ≤ 0.5 dB for 30 kHz to 100 Hz and ≤ 2.0 dB for 30 kHz to 10 Hz.

SWEEP CHARACTERISTICS

Frequency Span — Provides calibrated frequency spans from 50 Hz/div to max (500 kHz/div) within 4% in 1-2-5 sequence.

Horizontal linearity is within 4% over the entire 10 div display.

A 0-Hz/div position is provided for time domain operation.

20 Hz to 5 MHz Plug-in Spectrum Analyzer

CHARACTERISTICS WITH PLUG-IN INPUT IMPEDANCE MODULE

	L1	L2	L3	L3-1
INPUT CHARACTERISTICS				
Input Impedance —	50 Ω	75 Ω	1 MΩ/28 pfF (also 75 Ω and 600 Ω)	
Input Power — Max input power for reference levels:				
above 0 dBm	+21 dBm		+21 dBm	
below 0 dBm	+10 dBm		+21 dBm	
			100 V (peak ac + dc) @ 1 MΩ input z	
AMPLITUDE CHARACTERISTICS				
Residual Response — Internally generated spurious signals (referred to input).	−130 dBm or less −125 dBm for calibrator and harmonics		−143 dBV or less −138 dBV for calibrator and harmonics	
Sensitivity — Equivalent input noise for each resolution bandwidth setting is measured in VIDEO AVERAGE mode with 10 s/div sweep rate and INPUT BUFFER control off. Equivalent input noise for resolution bandwidth of:	*(equal to or better than)		*(equal to or better than)	
10 Hz	−135 dBm		−148 dBV	
30 Hz	−133 dBm		−146 dBV	
100 Hz	−130 dBm		−143 dBV	
300 Hz	−125 dBm		−138 dBV	
1 kHz	−120 dBm		−133 dBV	
3 kHz	−115 dBm		−128 dBV	
10 kHz	−110 dBm		−123 dBV	
30 kHz	−105 dBm		−118 dBV	
Sensitivity is further degraded 8 dB with INPUT BUFFER on. Noise level increases approx 10 dB operating in VIDEO PEAK mode.				
Intermodulation Distortion — Within any frequency span, intermodulation products for two, on screen, signals				
of any input level: 3rd order products	at least 75 dB down		at least 75 dB down	
2nd order products	at least 72 dB down		at least 72 dB down	
of any input level up to −53 dBv/−40 dBm (50 Ω): 2nd and 3rd order products	at least 80 dB down		at least 80 dB down	
of any input level with INPUT BUFFER on: 2nd and 3rd order products	at least 80 dB down		at least 80 dB down	
Display Flatness — Peak-to-peak display variation over any frequency span.	0.5 dB max		0.5 dB max (25 Hz to 5 MHz)	
	(Add 0.5% quantization error in digital storage)		0.75 dB max (20 Hz to 5 MHz)	
			(Add 0.5% quantization error in digital storage)	
On-screen Dynamic Range —	80 dB (full 8 div)		80 dB (full 8 div)	
Reference Level** — In LOG mode, reference level refers to top horizontal graticule line. Calibrated in dB steps.				
Range — LOG 10 dB/div mode	1 dB and 10 dB steps		1 dB and 10 dB steps	
LOG 2 dB/div mode	−78 dBm to +21 dBm		−83 dBV to +8 dBV	
LIN mode	−128 dBm to +21 dBm		−141 dBV to +8 dBV	
	20 nV/div to 200 mV/div in 1-2-5 sequence		20 nV/div to 200 mV/div in 1-2-5 sequence	
Accuracy—When calibrated @ −40 dBV in LOG mode.	Within 0.2 dB/dB, to max of 0.25 dB/10 dB change in reference level			
Display Dynamic Range Accuracy— LOG 10 dB/div mode	0.05 dB per dB to 2 dB max for 80 dB full screen			
LOG 2 dB/div mode	0.1 dB per dB to 1 dB max for 16 dB full screen			
LIN mode	±5%			

*Note: dBm = dBV −10 Log Z + 30 where Z = impedance
Example: dBV = [dBm (600 Ω — 2.22]

**Note: A > sign is displayed by the reference level readout when the reference level is not calibrated and the UNCAL light is on. A < sign is displayed when the reference variable is out of its detent.

Sweep Rate — Time per div is selectable from 10 s/div to 0.1 ms/div in 1-2-5 sequence. An AUTO position permits automatic selection of optimum time/div depending on resolution and span/div settings.

Sweep rate accuracy is within 5% of the rate selected.

Triggering — Provides two triggering sources, INT (internal) and LINE, in addition to a FREE-RUN position.

When INT is selected, ac coupled signal components from the mainframe trigger source (left or right vertical amplifiers) are used.

When LINE is selected, ac coupled sample of mainframe ac line voltage is used.

Three triggering modes are NORM (normal), SGL SWP/READY (single sweep), and MNL SWEEP (manual sweep).

Trigger level is ≥1.0 div of internal signal for both NORM and SGL SWP modes over the approx frequency range of 30 Hz to 500 kHz.

OUTPUT CONNECTORS

Video Out — Front-panel pin jack connector supplies the video (vertical) output signal at an amplitude of 50 mV/div +5% (about the crt vertical center) with source impedance of 1 kΩ. (Analog signal prior to digitization for storage).

Horiz Out — A front-panel pin jack connector supplies horizontal output signal (negative-going sawtooth that varies from about 0 to about −6 V dc with a source impedance of 5 kΩ).

Calibrator — Front-panel BNC connector supplies a calibrated 500 kHz square wave output signal (derived from the analyzer's time base). Output amplitude is within ±0.15 dB of −40 dBV into the plug-in impedance.

OPTION 25 TRACKING GENERATOR CHARACTERISTICS

Frequency Range — 20 Hz to 5.0 MHz.

Output Impedance — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

Amplitude — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

Range —
50 Ω, 0 dBm to −63 dBm
75 Ω, −6 dBm to −69 dBm
600 Ω, −17 dBm to −80 dBm

Accuracy — (Max Output calibrated at 500 kHz)
50 Ω, 0 dBm ±0.25 dB
75 Ω, −6 dBm + 0.4, −0.2 dB
600 Ω, −17 dBm +0.5, −0.1 dB

Attenuator —
Range: 0 to 63 dB in 10 dB or 1 dB steps.
Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

Flatness —
50 Ω and 75 Ω: Within 0.5 dB peak-to-peak.
600 Ω: Within 1.0 dB peak-to-peak.
Total System Flatness (7L5 with Option 25)
50 Ω and 75 Ω: Within 1.0 dB peak-to-peak.
600 Ω: Within 1.25 dB peak-to-peak.

Dynamic Range (7L5 with Option 25) — ≥110 dB.

Residual FM (peak-to-peak) —
Spans to 2 kHz/div: 2 Hz (7L5 with Option 25).
Spans 5 kHz/div or greater: 40 Hz (7L5 with Option 25).

Stability — 25 Hz/5 minutes after 10 minute warm-up decreasing to 25 Hz/hr maximum after 1 hour.

Spurious Suppression, 10 Hz to 5.0 MHz (Harmonic and non-harmonic — 40 dB or more with respect to the carrier.

Auxiliary Output — ≥200 mV rms into 50 Ω.

ORDERING INFORMATION

7L5 Spectrum Analyzer **$8000**
(Spectrum Analyzer Requires L Plug-in Module.)

Option 25 with Tracking Generator ..... **Add $1200**

For a separate tracking generator, (One-wide field modification to be attached to an existing 7L5) order 040-0810-00 ..... **$1250**

Option 33 combines Options 21, 25 and 28 .. **Add $2500**

Included Accessories — Graticule, Spectrum Analyzer 337-1159-00 (7000 Series), and 337-1439-01 (7603). Filter, light blue 378-0684-00.

L1 Plug-in Module (50 Ω) **$830**

L2 Plug-in Module (75 Ω) **$640**

L3 Plug-in Module (1 MΩ, 50 Ω, 600 Ω) $1200

Option 01 (1 MΩ, 75 Ω, 600 Ω) ..... **No Charge**

L1-GC Module (50 Ω) ..... **Request Quote**

†7603 Oscilloscope **$2555**

†R7603 Oscilloscope (Rackmount) **$2955**

Option 06 Internal S A Graticule ..... **Add $50**

Option 08 Protective Front Cover (Cabinet Only) ..... **Add $100**

†7704A Oscilloscope **$4220**

†R7704 Oscilloscope **$6270**

†Suggested Mainframe. See 7000 Series pages for oscilloscope specifications and options.

OPTIONAL ACCESSORIES

Tracking Generator, one-wide field modification kit, to be attached to an existing 7L5 040-0810-00 ..... **$1250**
2701 50 Ω Step Attenuator **$455**
2703 75 Ω Step Attenuator **$490**
75 Ω to 50 Ω Min Loss Attenuator (Ac Coupled) 011-0112-00 ..... **$60**
P6105 10X Probe, (2m) 010-6105-03 ..... **$90**

BALANCED INPUT TRANSFORMER

Frequency Range — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

Flatness — 0.25 dB peak-to-peak maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

Common-Mode Rejection — 25 dB minimum (50 kHz to 3 MHz).

Output Termination — Switchable between 124Ω, 135Ω, and NONE for bridging or external termination.

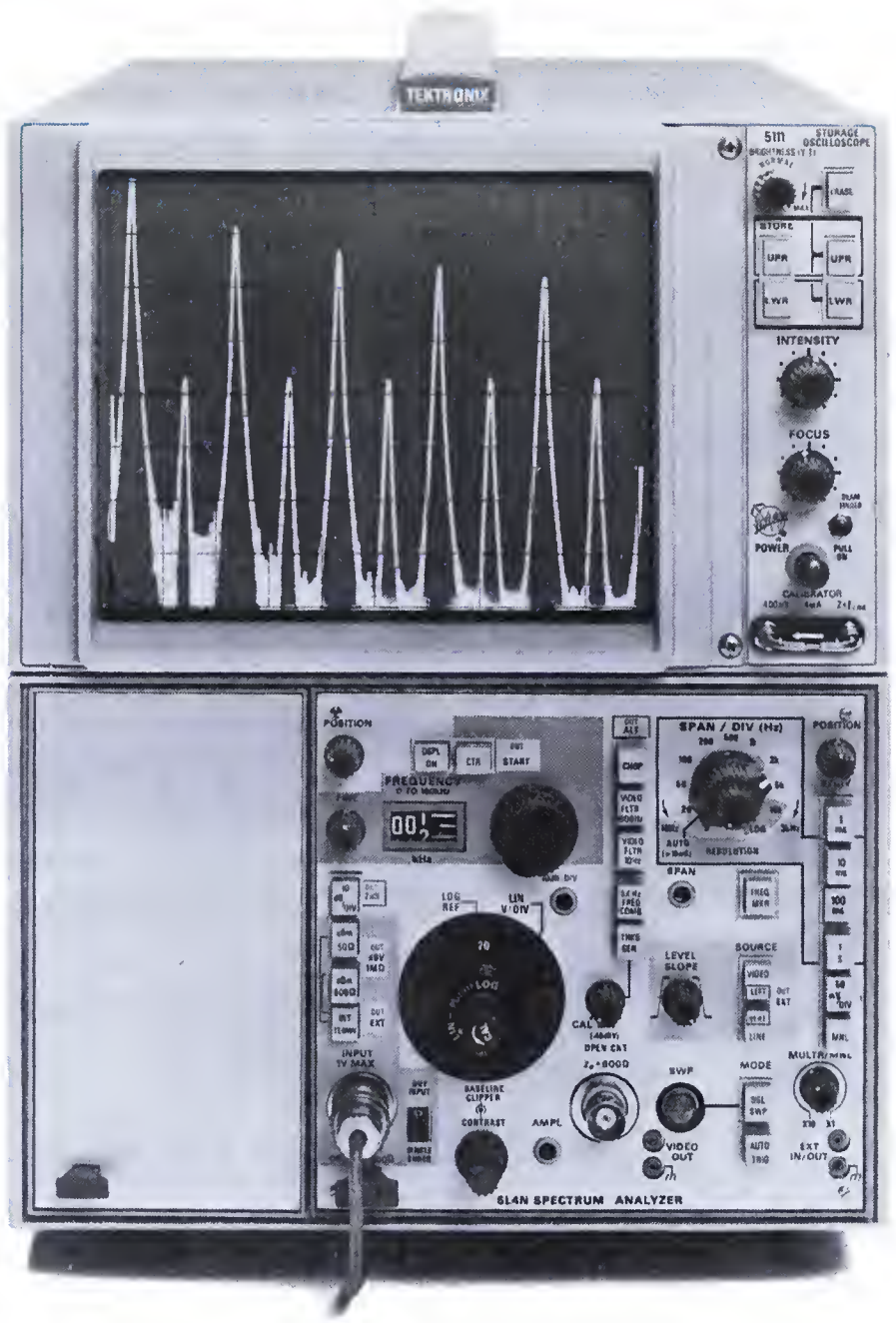
Connectors — WECO (0.37 in with 0.090 center) on 0.625 in spacing for balanced input. BNC for single-ended output.

Balanced Input Transformer 013-0182-00 ..... **$150**

20 Hz to 100 kHz Plug-in Spectrum Analyzer

5L4N

- 20 Hz to 100 kHz
- Selectable Impedance
- Calibrated Appropriate to Impedance Selected
- Single-Ended Input
- Differential (Balanced) Input
- On Screen Dynamic Range 80 dB (Full 8 div)
- Intermode >70 dB Down
- Resolution Bandwidth 10 Hz to 3 kHz
- Auto Resolution
- Built-in Tracking Generator
- 20 Hz to 20 kHz Log Sweep*



5L4N Spectrum Analyzer with 016-0452-00 Blank Plug-in Panel in a 5111 Storage Oscilloscope.

The 5L4N is a 20 Hz to 100 kHz spectrum analyzer that offers both high performance and economy. The analyzer features selectable input impedances, 80 dB of dynamic range and a built-in tracking generator.

This spectrum analyzer is especially suited for noise and distortion studies in the audio range and comes equipped for 20 Hz to 20 kHz log sweeps.

Many educators prefer this economical analyzer to teach frequency-related theory and demonstrate practical application in the areas of speech, sound, music, vibration, audio, broadcasting and many others.

5L4N Spectrum Analyzers Serial number B071704 or higher can be used with any 5000 Series Mainframe including the 5223. Older 5L4N Spectrum Analyzers may be plugged into any 5000 Series Mainframes except the 5223. Only two compartments are occupied by the anaylzer so that, with the addition of a vertical plug-in, basic oscilloscope functions may be obtained. We recommend the use of a 5111 Storage Oscilloscope for maximum utilization of the analyzer.

*100 Hz to 100 kHz also available.

FREQUENCY CHARACTERISTICS

Range — 20 Hz to 100 kHz. Accuracy ±3 kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Resolution Bandwidth — The resolution bandwidth is continuously variable from 3 kHz to 10 Hz. An AUTO mode provides the best resolution for the frequency scan and sweep rate selected. Signal level change over the resolution bandwidth range is 2 dB or less. Line frequency modulation of 50 Hz or more can be resolved up to 70 dB below the signal level. In the log sweep mode the resolution bandwidth changes with frequency giving an effect similar to octave bandwidth sweeps.

Stability — Within 30 Hz over a 10 min period, at a fixed ambient temperature.

Incidental Fm — 2 Hz (p-p) or less.

AMPLITUDE CHARACTERISTICS

Reference Level Range —
Log 10 dB/div:
from −10 dBm/dBV to −70 dBm/dBV, within 0.4 dB/10 db to max of 1 dB at −70 dBm/dBV.

Log 2 dB/div:
from −10 dBm/dBV to −130 dBm/dBV within 0.4 dB/10 dB to max of 1 dB at −70 dBm/dBV and 3 dB at −130 dBm/dBV.

Linear:
from 50 mV/div to 20 nV/div within 5% decade.

Cw Sensitivity (Signal Level + Noise = 2X Noise) — The following characteristics are applicable with the input internally terminated, or with a 600 Ω or less source impedance.

	Resolution Bandwidth	
Display Mode	**3 kHz**	**10 Hz**
dBV	−123 dBV	−147 dBV
dBm 50 Ω	−110 dBm	−134 dBm
dBm 600 Ω	−121 dBm	−145 dBm
LINEAR	680 nV	45 nV

Flatness (20 Hz-100 kHz) — Flatness remains within ±0.2 dB, over any selected frequency span, with respect to the level of −40 dBV signal at 5 kHz. Intermodulation Distortion — with two signals, within any frequency span, that are less than or equal to the reference level:

−10 dBm/dBV	≥70 dB down
≤ −20 dBm/dBV	≥75 dB down

Internal Spurious Signals — Equal to or less than −130 dBm/dBV referred to the input. Line related spurii less than −120 dBm/dBV.

Dynamic Range — 80 dB (8 div).

INPUT CHARACTERISTICS

Selectable Impedance — 1 MΩ/47 pF or 600 Ω or 50 Ω (single-ended or differential).

Differential Input Characteristics — Full screen limit is approx 300 mV to 400 mV. Common-mode rejection ratio is 70 dB or more.

Single-Ended Input Characteristics — Max single input for linear operation: −10 dBm/dBV or 0.316 V rms.

SWEEP CHARACTERISTICS

Linear Frequency Span — 20 Hz/div to 10 kHz/div, 1-2-5 sequence. 4% accuracy.

Log Frequency Span — 100 Hz to 100 kHz internally reprogrammable from 20 Hz to 20 kHz.

Zero Frequency Span — Analyzer operates as a fixed tuned receiver for time-domain displays.

Internal Sweep Sources — Time base 1 s/div to 1 ms/div (increased up to X10 with multiplier).

Triggering — Internal at least 0.1 div, External at least 250 mV. Slope and level selection are provided. Auto Trigger provides a sweep baseline when a trigger signal is absent. Single sweep provided.

Manual Sweep — Provided.

External Sweep — Requires 0 V to 500 mV ±50 mV; from a 1 kΩ or less source to sweep the full span.

OUTPUT CONNECTIONS

Tracking Generator — 600 Ω source. Calibrated output level is −40 dBV ±0.2 dB (10 mV) open circuit, or −46 dBV when terminated into 600 Ω. Output level can be varied from approximately 0.001 V to 0.1 V open circuit.

5 kHz Freq Comb — 600 Ω source of 5 kHz ±0.005% markers for span calibration.

Video Out — Provides 250 mV ±5% of video signal per display div (0 V to 2 V). Source impedance is about 1.0 kΩ.

Ext In/Out — Provides 500 mV ±25 mV, per div of span, from 0 to 5 V, when using internal or manual sweep.

INCLUDED ACCESSORIES

013-0156-00 Adapter, Floating BNC to Dual BNC. 175-1178-00 BNC to Pin Jack Adapter Cable. 331-0429-00 Log Graticule (20 Hz-20 kHz).

ORDERING INFORMATION

5L4N Spectrum Analyzer $4000

We recommend that the Plug-in 5L4N be ordered with a storage mainframe.

5111 Storage Oscilloscope (Cabinet) $1850
Option 02 Protective Front Cover ..... Add $25

R5111 Storage Oscilloscope (Rackmount) $1900

OPTIONAL PLUG-INS FOR TIME DOMAIN USE

5A15N Single Trace Amplifier $260
5B10N Time Base Amplifier $405

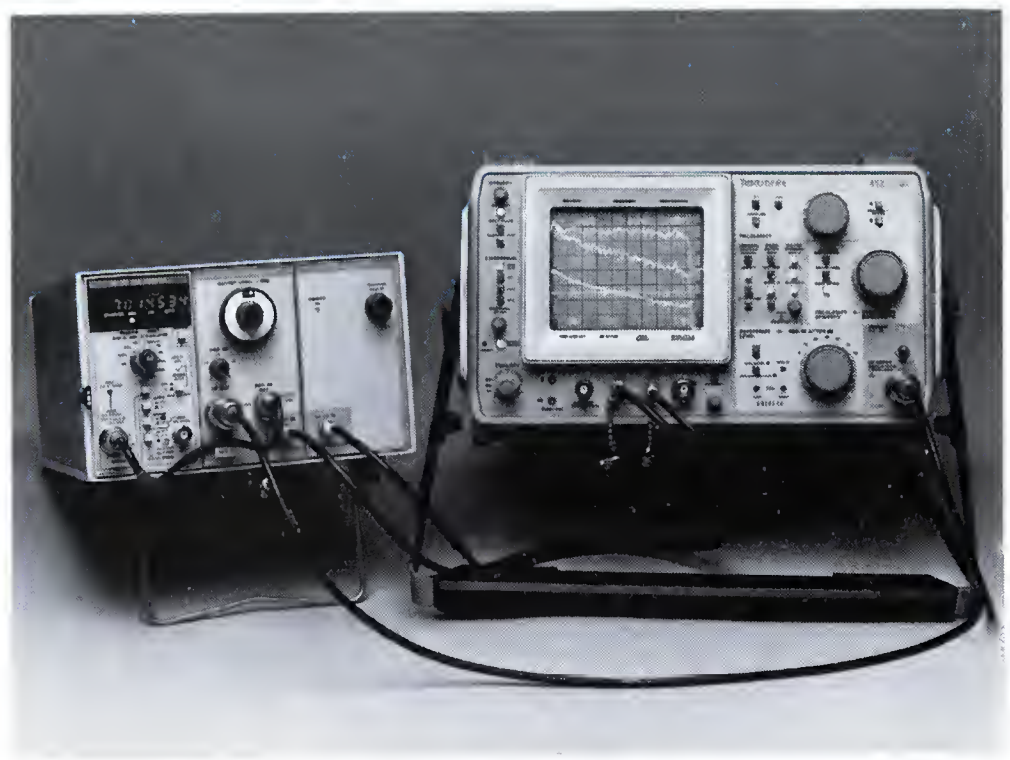
OPTIONAL ACCESSORIES

010-0160-00 10X Probe P6006 (6 ft.) $72
016-0452-00 Blank Plug-in Panel $15
2701 Step Attenuator (50 Ω) $455

600 Ω Attenuator, 51 dB in 1 dB steps
011-0093-00 ..... $250

100 kHz to 1800 MHz Tracking Generators

For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DC 508A Option 07 Digital Counter, in a TM 503 Option 07 Power Module, with a 7L13 Spectrum Analyzer in 7613 Option 06 Mainframe.



TR 503 Tracking Generating used with a DC 508A Option 01 Digital Counter, in a TM 503 Power Module, with a 492 Spectrum Analyzer.

TR 502 NEW TR 503

TR 502 Has Automatic Counter Dot Marker When Used with DC 508A Option 07 and 7L13

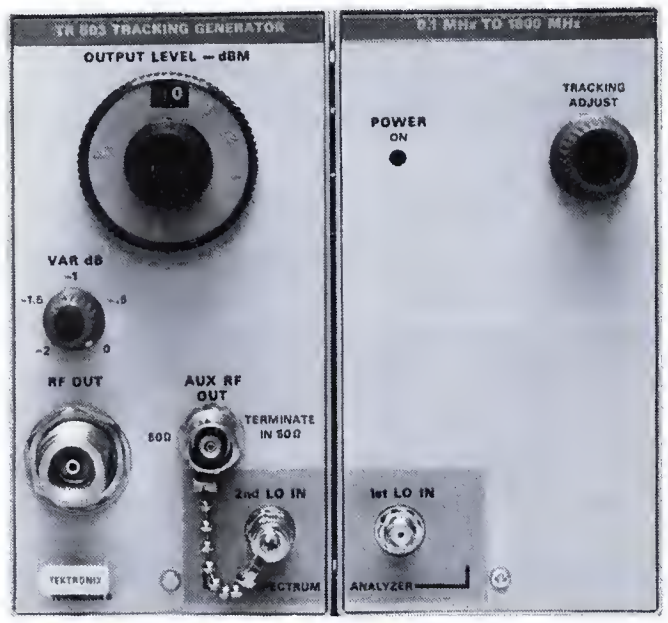
The TR 502 works with the 7L12 and 7L13 and TR 503 works with the 492/492P Spectrum Analyzer to provide constant level, calibrated rf sources for swept frequency tests to 1800 MHz.

When used as a cw source, with the analyzer in a manual mode, these systems have excellent stability. This stability enhances the narrow bandwidth measurement capability of the analyzer/tracking generator combination.

The tracking generators are two-wide units compatible with the TM 500 Modular Instrument Series.

The TR 502/TR 503 AUX RF OUTPUT may be used to drive a frequency counter. Frequencies up to 1800 MHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.



OUTPUT CONNECTORS

Included accessories TR 502 — Two 50 Ω coaxial cables 012-0649-00, logic interface cable, 012-0648-00, adapter N male to BNC female 103-0045-00, retainer plug-in 343-0604-00 fixed 10 dB attenuator with 3 mm fittings 307-0553-00.

Included accessories TR 503 — Two 50 Ω coaxial cables, 28.5 in. 012-0649-00, Adapter, "N male to BNC female" 103-0045-00, Adapter, SMA Male to BNC Female adapter 015-108-00, Retainer Plug-in 343-0604-01.

CHARACTERISTICS

	TR503/492/492P	TR502/7L13	TR502/7L12
Freq. Range	100 kHz —1.8 GHz	100 kHz —1.8 GHz	100 kHz —1.8 GHz
Output Level	(Max) 0 dBm ±0.5 dB	0 dBm ±0.5 dB	0 dBm ±0.5 dB
Range	0 to —59 dB in 10 dB and 1 dB steps	0 to —59 dB in 10 dB and 1 dB steps	0 to —59 dB in 10 dB and 1 dB steps
Flatness	Within ±2.25 dB Max from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±2 dB max from 100 kHz to 1.8 GHz (Typically ±1.5 dB)	Within ±3.0 dB max from 100 kHz to 1.8 GHz (Typically ±2.0 dB)
Dynamic Range	≥110 dB	≥110 dB	≥100 dB
Residual FM	50 Hz p-p	10 Hz p-p	200 Hz p-p
Output Impedance	50 Ω Nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz	50 Ω nominal, VSWR 2:1 or less to 1.8 GHz
Auxiliary Output	0.1 V RMS Into 50 Ω Load	0.1 V RMS Into 50 Ω Load	0.1 V RMS Into 50 Ω Load
Spurious Output	Harmonic 20 dBc Non Harmonic 40 dBc	Harmonic 20 dBc Non Harmonic 40 dBc	Harmonic 20 dBc Non Harmonic 40 dBc

ORDERING INFORMATION

TR 502 Tracking Generator $5750

Suggested Complementary Items

TM 503 Option 07 Power Module $295

DC 508A Option 07 Digital Counter $250

Blank Panel 016-0195-03 .....$11

10 dB, 3 mm attenuator 307-0553-00
(used in the 2nd LO Input line to Improve TR 502/7L12 Isolation) **$120**

TR 503 Tracking Generator $6300

Suggested Complementary Items

TM 503 Power Module $270

DC 508A Option 01 Digital Counter .....Add $1250

Blank Panel 016-0195-03 .....$11

TV Sideband Adapter, CATV Preamplifier and Attenuators

1405/7L12 Sideband Analyzer System.

1405

Response of Transmitter under Test within ±0.2 dB

Frequency Response of Rf and If Circuits for Transmitters with Frequency to 1 GHz

Video Circuits Can Be Swept

For In-service Testing, Use of External Blanking Allows Either Full-field or Single-line Operation

Check Aural Fm Deviation with Built-in Bessel Null Technique

Flexible Marker System Will Accept Standard Crystals

To analyze the sideband response of a television transmitter, the 1405 Sideband Adapter is used with a spectrum analyzer, such as the 7L12 or 7L13. The 1405 generates a composite video signal, the "picture" portion of which is a constant-amplitude sinusoidal signal that sweeps 15-0-15 MHz. This signal is applied as modulation to a television transmitter; the output is then displayed on the spectrum analyzer, and appears as the response curve of the transmitter under test. The 1405/Spectrum Analyzer combination will display the frequency response characteristics of rf and if circuits for transmitters with frequencies to 1 GHz. Video circuits (zero frequency offset) can also be analyzed.

Complete specifications and prices are available in the Television Products Catalog.

ORDERING INFORMATION

1405 TV Sideband Adapter 525/60 Markers) $4160

Option 01 TV Sideband Adapter (625/50 Markers) . . . . . Add $100

OPTIONAL ACCESSORIES

Rackmount-conversion kit for mounting 1405 or 1405 Option 01 in std. 19 inch rack. 016-0489-00 . . . . . $250

2701
2703

Step Attenuators

The 2701 and 2703 Step Attenuators are laboratory quality, bench top instruments for attenuation of large value radio frequency signals. The 2701 50 Ω Attenuator is particularly useful in making receiver sensitivity and distortion measurements. The range of attenuation is 0 to 79 dB, selected in 1 dB steps with tens and units cam switches. A front-panel switch selects DC, AC, or DC TERM (a 50 Ω precision termination).

The 2703 75 Ω Step Attenuator is tailored for television, CATV, telephone and radio applications. A front panel switch extends the range to 109 dB, making the attenuator an ideal accessory for wide-range measurements such as cross modulation, signal-to-noise and receiver sensitivity. A dc block has been incorporated for both rear-panel ports to protect the attenuator against accidental burnout from high dc offsets or ac power on center conductors.

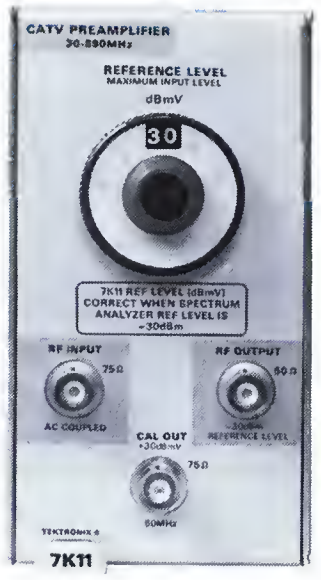
The board assemblies and thick-film hybrid attenuation chips used in both instruments are mounted in a sturdy metal housing; solid top and bottom plates provide excellent mechanical and electrical stability. The two cam switches which select individual chips operate through gold-plated switch contacts. Held on a four-layer circuit board with spring clips, the chip substrates can be replaced easily in the field.

The attenuators may be used for frequencies up to 2 GHz, with slight degradation of the attenuation accuracy and vswr characteristics specified at 1 GHz.

ORDERING INFORMATION

2701 50 Ω Step Attenuator $455

2703 75 Ω Step Attenuator $490



7K11
Preamplifier

This plug-in preamplifier is designed for spectrum analyzer applications where extra sensitivity is required. This amplifier is tailored to the CATV and field intensity measurement markets, providing a 75 Ω input impedance and calibration in dBmV. The low noise figure makes the preamplifier well-suited for signal-to-noise and low-level radiation measurements.

CHARACTERISTICS
(with 7L12 and 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is no greater than 5 dB.

Intermodulation Distortion (with 7L12 or 7L13) — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for: third order intermodulation with two signals at the reference level (full screen).

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

Input Impedance — 75 Ω.

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

Accessories — BNC to BNC 50 Ω Cable, 5.5 inch: 012-0057-01; BNC to F Adapter: 013-0126-00; BNC to BNC 75 Ω Cable, 42 inch: 012-0074-00.

ORDERING INFORMATION

7K11 CATV Preamplifier $830

STEP ATTENUATOR CHARACTERISTICS

CHARACTERISTICS	2701	2703
Attenuation	0 to 79 dB in 1 dB steps	0 to 109 dB in 1 dB steps (Including extra 30 dB range)
Impedance	50 Ω nominal	75 Ω nominal
Frequency	Dc to 1 GHz	3 kHz to 1 GHz*
Max Average Input Power	1.5 W to 65°C.	1.5 W to 65°C
Signal Coupling	Dc, ac, and dc terminated at one port only	Ac only both PORTS*
Size	7.5 in lg x 4.5 in w x 2.5 in h	7.5 in lg x 4.5 in w x 2.5 in h
Connector	Type BNC Female 50 Ω	Type BNC Female 75 Ω

**Blocking capacitors may be removed for specialized applications.*

PADS AND ADAPTERS

75 Ω to 50 Ω Minimum Loss Attenuator with dc block, 5.7 dB loss **011-0112-00** **$60**

75 Ω to 50 Ω Matching Attenuator with 11.25 dB conversion factor from dBm to dBmV with dc block **011-0118-00** **$60**

Fixed 10 dB attenuator with 3 mm fittings for use with TR 501/TR 502 with 7L12 **307-0553-00** **$30**

Dc Block BNC to BNC max dc potential 50 volts **015-0221-00** **$85**

"F" Female to BNC Male Adapter 013-0126-00 .... **$15**

BNC Female to "F" Male 103-0158-00 ..... **$8.50**

Calibrator Jumper 50 Ω BNC to BNC 5.5 in **012-0214-00** **$30**

Jumper Cable BNC to BNC 50 Ω, 42 in **012-0057-01** **$17**

Jumper Cable BNC to BNC 75 Ω, 42 in **012-0074-00** **$17**

"N" Female to BNC Male 103-0058-00 ..... **$7**

PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe or instruments.

7000 Series 3 Hole Mainframe Cover 016-0192-01 ..... **$17**

7000 Series 4 Hole Mainframe Cover 016-0531-00 ..... **$15**

5000 Series Mainframe Cover 016-0544-00 ..... **$25**

RIGID FRONT COVERS

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613, or the Option 02 Protective Front Cover for 5100 Series Mainframes.

Protective Front Cover for existing 7603 or 7613 Mainframes:

Blue, 040-0835-00 ..... **$125**
Gray, 040-0628-00 ..... **$125**

GRATICULES, FILTERS

Plastic Implosion Shield and S A Graticule 7613 and 7623 Mainframes **378-0625-07** **$5**

Plastic Implosion Shield and S A Graticule 7403 and 7603 Mainframes **337-1439-01** **$5**

Plastic Implosion Shield and S A Graticule All other 7000 Series Mainframes **337-1159-02** **$5**

(Internal graticules are available with most 7000 Series Mainframes)

EMC Metal Screen Mesh Filter for 7500, 7700 Series Instruments **378-0603-00** **$30**

EMC Metal Screen Mesh Filter for 7400 Series Instruments **378-0696-00** **$30**

Audio 20-20 kHz Log Graticule for 5000 Series Instruments **331-0429-00** **$2.50**

IRIG Log Graticule for 7L5 331-0421-00 ..... **$2.50**

Complete selection of colored filters is available in the accessories section.

PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L12, 7L13 and 492 Spectrum Analyzers:

FET Probe P6201 to 900 MHz 010-6201-01 ..... **$885**

FET Probe P6202 to 500 MHz 010-6202-01 ..... **$550**

Conventional Probe P6056 Dc to 3.5 GHz 6 ft. 010-6056-03 ..... **$120**

Conventional Probe P6057 Dc to 1.4 GHz with Adapter **010-6057-03** **$125**

Current Probe P6022 to 150 MHz 015-0135-00 .... **$290**

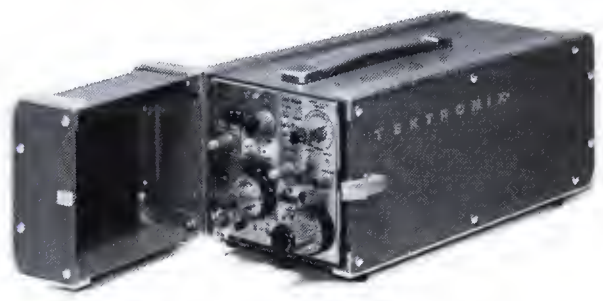
Complete specifications are available in the probes and accessories section.

CAMERAS

A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 5000 and 7000 Series Instruments are:

Polaroid Film Back C-59P **$950**

Complete specifications on all cameras are available in the Camera section.



CARRYING CASES AND MOUNTS

Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L12 or 7L13 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired. Securing Kit, fits 7L12 or 7L13, **016-0637-00** **$36**

3-wide Carrying Case for 7L13, 7L5 Option 25, etc. 016-0626-00 ..... **$195**

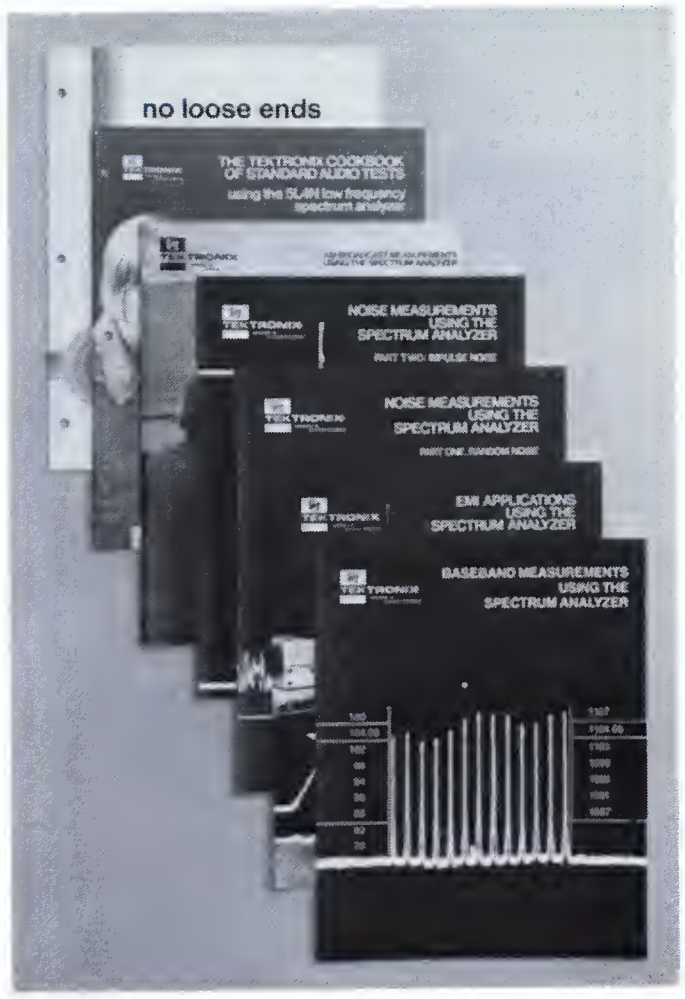
2-wide Carrying Case for 7L12, 7L5, etc. 016-0625-00 ..... **$195**

Luggage-type Carrying Case for 7603 Opt 08, 7613 Opt 08 016-0628-00 (Analyzer must have 016-0637-00 Securing Kit) **$315**

Hard Case (transit) (016-0658-00) **$495**

Soft Case (016-0659-00) **$125**

Your local field office or representative can quote prices and availability on any of these accessories.



Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMC, am, fm, two-way radio and television measurements, cable television proof of performance, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Field Office or Representative.

Option 08 protective front cover is shown with 7613 Mainframe.

TDR Cable Testers

Portable —
Battery Powered, Self-Contained, Light

Rugged —
Meets MIL-T-28800, Type III, Class 3, Style A

Versatile —
Test Any Type Paired Conductor and Coax Cable

Easy to Use —
Produces Results with Minimal Operator Training

Time Domain Reflectometry *TDR

The portable, rugged 1502 and 1503 TDR Cable Testers are field maintenance tools that are simple to operate and will test any transmission cable under virtually any conditions. The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications.

These units use a technique called Time Domain Reflectometry (TDR) to identify and locate cable faults. When connected to a line in the cable, the unit sends out an electrical pulse that is reflected back to the unit by a fault in the cable. Fault type is identified by the shape of the display, and fault distance is determined by the displayed interval from the test pulse to the fault pulse.

For easy carrying and operating in tight spaces, these units are lightweight and small and will operate at least five hours on the internal, rechargeable batteries.

Since permanent records are useful in cable maintenance, an optional, plug-in chart recorder is available for paper recording of the test. The standard plug-in X-Y Output module can drive an external X-Y Recorder.

1502
This unit is directly calibrated in reflection coefficient (rho) and distance. The 1502 uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet, but with decreasing resolution as the fault distance increases. The unit is matched to 50-ohm cables, but may be used on others by adjusting the front panel GAIN control or using optional impedance adapters.

***Also known as cable radar.**

1503
For long cables, the 1503 provides high-energy, ½-sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet. Resolution capability provides for resolving faults as close together as three feet on short cables. Impedance levels of 50, 75, 93 and 125 ohms are selectable.

1503 Option 01
1503 Option 01 has DISTANCE CAL switches that make it more convenient for fault location in a variety of cables including coax. When the 1503 Option 01 has been calibrated for each cable before trouble occurs, and the records are kept, the DISTANCE CAL switches can be set exactly and damage location can begin immediately.

Metric Instruments (1502, 1503)
For distance measurements in meters, instead of feet, there is Option 05 of both the 1502 and 1503. These instruments are fully metric versions of the 1502 and 1503 with no conversion from feet to meters involved.

The 1502 Option 05 has a distance resolution of 1.5 cm and measures 500 meters.

The 1503 Option 05 has a resolution of .9 meter and measures 10,000 meters.

PA1 Cable Comparator
The PA1 Cable Comparator is used with the 1503 to amplify the test pulse and test two lines at the same time. This means instant comparison of a bad line with a good one, the ability to see cross-talk and a clear picture of faults on noisy or lossy lines.

The PA1 is connected between the 1503 and the cable to be tested, with the results displayed on the 1503 for measurement.

Portable TDR Cable Testers

1502

TEST SIGNAL

Shape — Step rise.

Amplitude — 225 mV nominal (into 50 Ω load), dc coupled.

Aberrations — Within ±5% during 1st 10 ft. after rise. Within ±0.5% peak beyond 10 ft. NOISE FILTER "out."

System Reflected Rise — ≤0.07 ft. (≤140 ps).

Jitter — ≤0.02 ft. (≤40 ps) for X.1.
≤0.1 ft. (≤200 ps) for X1.

Test Connector — BNC.

Termination — 50 Ω, within ±2%.

Max Input — DO NOT APPLY EXTERNAL VOLTAGE.

VERTICAL SYSTEM

Display Range — ±4 div.

Accuracy — Within ±3%.

Calibration Point — 2 div=1 ρ.

Deflection Factor — 5 mρ/div to 500 mρ/div, 7 steps, 1-2-5 sequence.

Variable — ≥3.5:1 from calibration point.

Displayed Noise —
NOISE FILTER switch "out": ±5 mρ or less.
NOISE FILTER switch "in": ±2 mρ or less.

HORIZONTAL SYSTEM

Distance Controls —
Distance Dial —
Range — 0 to 100 ft. for X.1.
0 to 1000 ft. for X1.
Accuracy — Within ±2% of reading ±0.05 ft. for X.1. Within ±2% of reading ±0.5 ft. for X1.
FEET/DIV Control:
Range — 0.1 to 20 ft./div for X.1. 1 to 200 ft./div for X1.
Accuracy — Within 2% of full CRT screen.

CABLE DIELECTRIC Scales (V_p/V_{air}) — SOLID POLY, 0.66; SOLID PTFE, 0.70; OTHER VAR, 0.55 to 1.0. VAR is calibrated for air when turned fully cw.

Sweep Repetition — 40 Hz within + 0 Hz, −10 Hz with NOISE FILTER switch "out." 4 Hz within ±20% with NOISE FILTER switch "in." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder).

1502 Included Accessories — Watertight front cover, TDR Slide Rule (003-0700-00); 50 Ω BNC Terminator (011-0123-00); Precision 50 Ω Cable (012-0482-00); Viewing Hood (016-0297-00); X-Y Output Module (016-0606-00); Replacement Fuses (for front panel) 110 V ac (159-0032-00) or 220 V ac (159-0029-01); Power Cord (161-0066-00); Mesh Filter (CRT) (378-0055-00); BNC Female-to-Female Adapter (103-0028-00).

UNIQUE 1502 OPTION 05 CHARACTERISTICS

TEST SIGNAL

Aberrations — Within ±5% during 1st 300 cm after rise. Within ±0.5% peak beyond 300 cm NOISE FILTER "out."

System Reflected Rise — ≤2.1 cm (≤140 ps).

Jitter — ≤0.6 cm (≤40 ps) for X.1.
≤3 cm (≤200 ps) for X1.

HORIZONTAL SYSTEM

Distance Controls —
Distance Dial —
Range — 0 to 25 m for X.1.
0 to 250 m for X1.
Accuracy — Within ±2% of reading ±0.02 m for X.1.
Within ±2% of reading ±0.2 m for X1.
METRES/DIV Control:
Range — 0.025 to 5 m/div for X.1.
0.25 to 50 m/div for X1.

1503

Shape — ½ sine within ±20%.

Amplitude — 10 V ±20% unterminated.
5V ±20% terminated, ac coupled.

Aberrations — −30 dB p-p. (Equivalent to ±1.6%).

Duration — ≤10 ft. (10 ns),*
≤100 ft. (100 ns),*
≤1000 ft. (1000 ns),*
*Duration times are within ±20% at half amplitude.

Jitter — ≤1 ft. for X10 (≤2 ns).
≤10 ft. for X100 (≤20 ns).

Test Connector — BNC.

Termination — 50 Ω, 75 Ω, and 93 Ω, within 1%; 125 Ω within 3%.

Max Input — ±400 V (dc + peak ac at max frequency of 440 Hz).

VERTICAL SYSTEM

Display Range — ±4 div.

Accuracy — Within ±0.25 dB (within ±3%).

Calibration Point — 2 div=0 dB.

Deflection Factor — 0 to 60 dB, 7 steps, 10 dB per step.

Variable — 0 to 18 dB additive to steps.

Displayed Noise —
NOISE FILTER switch "out": −80 dB rms, random.
NOISE FILTER switch "in": −86 dB rms, random.

HORIZONTAL SYSTEM

Distance Controls —
Distance Dial —
Range — 0 to 2,500 ft. at X10
0 to 25,000 ft. at X100
Accuracy — Within 2% of reading ±2 ft. for X10. Within 2% of reading ±20 ft. for X100.
FEET/DIV Control:
Range — 5 to 500 ft./div at X10. 50 to 5000 ft./div at X100.
Accuracy — Within 2% of full CRT screen.

CABLE DIELECTRIC Scales (V_p/V_{air}) — SOLID POLY, 0.66; FOAM POLY, 0.81; VAR, 0.31-1.0 VAR is calibrated for air when turned fully cw.

DISTANCE CAL Scales, Option 01 only (V_p/V_{air}) — Selectable from 0.2 to 1.0 in 0.01 increments.

Sweep Repetition — 40 Hz within +0 Hz, −10 Hz with NOISE FILTER switch "out." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder). 4 Hz within ±20% with NOISE FILTER switch "in."

1503 Included Accessories — Watertight front cover, Replacement Fuses (for front panel) 110 V ac (159-0032-00) or 220 V ac (159-0029-01); Power Cord (161-0066-00); Viewing Hood (016-0297-00); 50 Ω BNC Terminator (011-0123-00); X-Y Output Module (016-0606-00); Mesh Filter (CRT) (378-0055-00); 9 ft. BNC-to-Clip-Lead Cable (012-0671-02).

UNIQUE 1503 OPTION 05 CHARACTERISTICS

TEST SIGNAL

Duration — ≤3 m (10 ns),*
≤30 m (100 ns),*
≤300 m (1000 ns),*
*Duration times are within ±20% at half amplitude.

Jitter — ≤0.2 m for X1 (≤2 ns).
≤2 m for X10 (≤20 ns).

HORIZONTAL SYSTEM

Distance Controls —
Distance Dial —
Range — 0 to 500 m at X1.
0 to 5,000 m at X10.
Accuracy — Within 2% of reading ±0.2 m for X1. Within 2% of reading ±2 m for X10.
METRES/DIV Control:
Range — 1 to 100 m/div at X1.
10 to 1000 m/div at X10.

COMMON CHARACTERISTICS

POWER SYSTEM

Line Voltage — 117 V ac ±20%, 48 to 410 Hz, (234 V ac ±20%, 48 to 410 Hz available with Options A1-A4).

Battery Pack —
Operation: At least 5 hr (+20°C to +25°C charge and discharge temperature) including 20 chart recordings.

Full Charge Time: 16 hr.

Typical Charge Capacity:

Charge Temperature	Discharge Temperature		
	−15°C	+20°C to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

EXTERNAL RECORDER INTERFACE (STANDARD X-Y MODULE)

Horizontal — 0.1 V/div, source impedance is 10 kΩ.

Vertical — 0.09 to 0.13 V/div (adjustable), source impedance is 10 kΩ.

PHYSICAL CHARACTERISTICS

	in	cm
Height	5.0	12.7
Width (with handle)	12.4	31.5
(without handle)	11.8	30
Length (handle extended)	18.7	47.5
(handle not extended)	16.5	41.9
Net Weight	lbs	kg
(with front cover and acces.)	18	8.2
(without front cover or acces.)	16	7.3
Domestic Shipping (complete)	24.4	11.1
Export Shipping (complete)	36	16.3

ORDERING INFORMATION

1502 TDR Cable Tester **$4350**
Option 04 (with recorder) ..... **Add $775**
Option 05 (metric version) ..... **No Charge**
Option 76 (P7 Phosphor) ..... **Add $35**
234V International power cord and plug options A1 thru A4 available, see page 13 for full description.

1502 OPTIONAL ACCESSORIES

Chart Recorder — 016-0506-03 ..... **$800**
Chart Paper (roll) — **006-1658-01** **$6**
Chart Paper (100 roll case) — **006-1658-02** **$450**
Accessory Pouch — 016-0351-00 ..... **$25**
Static Suppressor for 1502—011-0132-00 ..... **$16.50**
Impedance Adapter —
50/75 Ω — 017-0091-00* **$65**
50/93 Ω — 017-0092-00* **$70**
50/125 Ω — 017-0090-00* **$65**
*Should be purchased with following two parts:
Connector, BNC Female-to-GR — 017-0063-00 ..... **$25**
Connector, BNC Male-to-GR — 017-0064-00 ..... **$35**

1503 TDR Cable Tester **$3780**
Option 01 (Distance Cal) ..... **Add $200**
Option 04 (with recorder) ..... **Add $775**
Option 05 (metric version) ..... **No Charge**
Option 76 (P7 Phosphor) ..... **Add $35**
234V international power cord and plug options A1 thru A4 available, see page 13 for full description.

1503 OPTIONAL ACCESSORIES

Chart Recorder — 016-0506-03 ..... **$800**
Chart Paper (roll) — **006-1658-01** **$6**
Chart Paper (100 roll case) — **006-1658-02** **$450**
Isolation Network
(for balanced lines) — **013-0169-00** **$155**
Adapter Cables (BNC-to-Clips) —
9 foot — 012-0671-02 ..... **$50**
30 foot — 012-0671-03 ..... **$60**
Accessory Pouch — 016-0351-00 ..... **$25**
Direct Current Adatper with Filter (for use with standard 12 V automobile lighter plug with negative ground)
25 foot cord — 015-0327-00 ..... **$105**

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

PA1 Cable Comparator

Test Pulse Amplitude —
15 V for 10 ns pulse width
25 V for 100 ns and 1000 ns pulse widths
Voltages ±20%

60 Hz Rejection — 40 dB.

PHYSICAL CHARACTERISTICS

	in	cm
Height	6.0	15.3
Width	7.25	18.4
Length	11.5	29.2
	lbs	kg
Net Weight	3.75	8.25
Shipping	6.75	14.85

POWER SYSTEM

Battery Powered — Requires four (4) ASA "D" size alkaline cells (not provided).

Service Life — 100 hours minimum.

ENVIRONMENTAL CHARACTERISTICS

Military Specification MIL-T-28800, Type II, Class 2, Style B was used as guideline for the environmental specifications.

Operating Temperature — −15°C to +5°C.

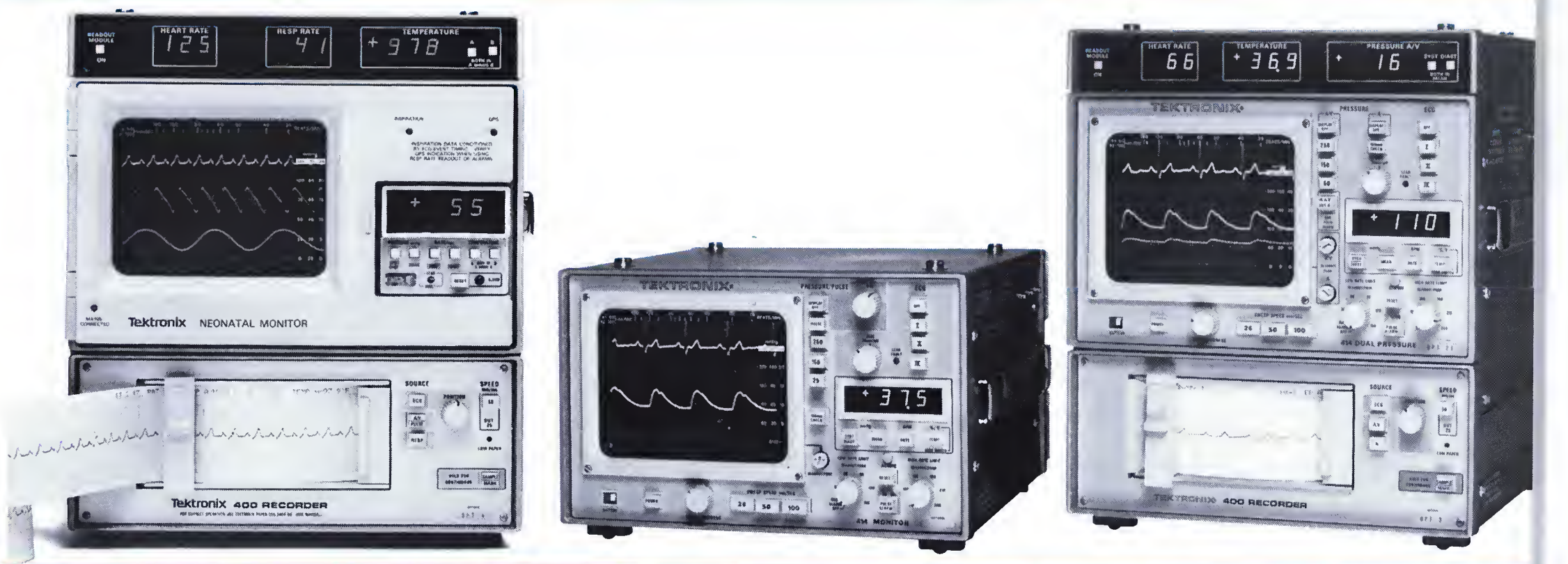
Water Resistance — Splash and drip proof. Cover removed.

Vibration — 3.0 g; 5 to 55 Hz.

Shock, Mechanical Pulse — 30 g. ½ sine shock.

PA1 Cable Comparator **$450**

Patient Monitors



NEW 413A Portable Patient Monitor

The Tektronix 413A Neonatal Monitor is a three-trace instrument that simultaneously displays ECG, blood pressure or peripheral pulse, and respiration waveforms A selectable digital readout shows heart rate, respiration rate, systolic/diastolic or mean blood pressure, two temperatures, or temperature difference.

This instrument was designed especially for neonatal monitoring. It is compact, lightweight, and can be operated by its own internal battery —in addition to ac—making it an ideal monitor for neonatal transport.

ADDITIONAL FEATURES:

- Respiratory-effort arrest alarm with 10- or 20-second delay.
- Separately settable heart-rate and respiration-rate alarms with continuously variable Hi-Lo limits. Digital display verifies limits.
- CVA rejection improves accuracy of respiratory-rate indication and alarms by ignoring most cardio-vascular artifacts in respiratory-effort signal.
- Audible and visual alarm signals.
- Three calibrated blood-pressure ranges.
- Pulse or pulsatile pressure failure alarm.
- Three-lead selection. Audible beep tone and visual indicator coincident with QRS complex.
- Automatic QRS detector minimizes disturbances caused by pacer pulses, muscle and motion artifacts.
- Four selectable sweep speeds.
- Adjustable waveform size control on ECG, pulse, and respiration.
- Rugged, die-cast construction.
- Weighs only 16 lb (7.0 kg). Dimensions: Height—6.0 in (15.3 cm); Width—9.0 in (22.8 cm); Depth—11.7 in (29.9 cm).
- Easily mounted for stationary use with a standard-accessory bracket or on an optional mounting pole.
- Built-in ECG respiration test signal to check patient-lead integrity.
- Built-in conditioning circuits to maximize battery operating time and extend battery service life.

414 Portable Patient Monitor

This dual trace instrument displays ECG and blood pressure or peripheral pulse, and provides a digital readout of heart rate, systolic/diastolic pressures, mean blood pressure, or temperature. The standard monitor features three-lead selection plus pressure and heart rate alarm limits, selectable sweep speeds, and ac or internal battery operation. Options include full-lead selection and dual pressure display.

401 Series Digital Readout Modules For 413A, 414 and 414 Option 21

Each module provides three dedicated digital readouts in addition to the monitor readout. On the 413A: ECG, respiration rate, and temperature (select between one of two temperature channels or the difference between temperatures). On both the 414 and 414 Option 21: ECG, temperature and blood pressure (select either systolic, diastolic or mean pressure). The module for the 414 Option 21 (dual pressure) is dedicated to the arterial/venous pressure channel. Modules are light weight (1.02 kg—2 lbs. 4 oz.) and only 1⅜ inches (3.5 cm) high. Ac or battery power is supplied by the monitor. No external cables are required.

Modules ordered to retrofit to an already-purchased monitor should be installed at your local Tektronix Service Center (nominal charge for installation).

400 Series Recorders

These six-pound hard copy units attach directly to TEKTRONIX Patient Monitors and provide thermal printout records of ECG, blood pressure, or peripheral pulse waveforms. They also provide an alphanumeric printout in the margin of the thermal copy, recording all digital information processed by the monitor.

414 Option 21 Portable Patient Monitor

(Shown above with 400 Series Recorder and 401 Series Digital Readout Module) — This three-trace instrument offers simultaneous CRT display of ECG and two blood pressure waveforms. First pressure channel is Arterial/Venous with three pressure ranges; second channel is Arterial dedicated to 250 mm Hg. Digital readout displays systolic/diastolic and mean blood pressures from either pressure channel, heart rate, and temperature. Ac or battery operation. Options include full lead select

ORDERING INFORMATION

413A Portable Neonatal Monitor $5100
Options A1-A4 . . . . . No Charge
For full description of the International Power Cord and Plug Options see page 13.
Standard 414 Monitor $3800
414 Option 21 Monitor $4600
Standard 401 Digital Readout Module (for 413A) $1150
Model, 401, Option 01 (for 414) $1150
Model 401, Option 02 (for 414, Option 21) $1150
Standard 400 Recorder (for 408 Monitor) $1600
Model 400, Option 01 (for 412) $1700
Model 400, Option 02 (for 414 Series—except Opt. 21) $2900
Model 400, Option 03 (for 414, Opt. 21) $2900
Model 400, Option 04 (for 413 A) $2900

Patient Monitors

Tektronix physiological monitors provide the medical professional with a full range of vital-signs monitoring in portable, compact packages. One instrument, for example, monitors ECG alone. Yet another monitors everything from ECG to pulse, respiration, temperature (including temperature from two body areas) and pressure, with systolic/diastolic or mean blood pressure readout. (Our 414 Option 21 even displays dual pressure simultaneously with ECG.) Our 401 Series Digital Readout Modules provide additional digital readouts, and the 400 Series Recorders deliver hard copies (both waveform and alphanumerics) for a permanent record. Units are ac or battery powered, easy to operate and completely self-contained.

As an additional feature, your Tektronix Patient Monitor can be serviced by trained professionals at Tektronix Service Centers or through our distributors worldwide. Find out how Tektronix can provide a better solution to your monitoring needs. Simply check the appropriate box on the reply card at the back of this catalog now, or call our Hot Line toll free within the continental U.S., 800-547-4804.

Tektronix Offers Varied Service Agreements and Leasing Plans.

- Service Agreements covering TEKTRONIX Portable Patient Monitors vary in duration and cost according to service and use requirements.
- The basic Tektronix lease agreement covers periods of one to three years in six-month increments and offers low cost renewal for one-year periods. An option to purchase plan is also available.

408 ECG Monitor—

This low cost, single-trace instrument is designed for applications requiring ECG measurements only. It features three-lead selection, variable heart rate alarm limits, three selectable sweep speeds, and ac or internal battery operation. Full lead selection is optional.

Standard 408 Monitor **$2100**

412 Portable Monitor—

This model offers dual-trace, three-lead selectable ECG and blood pressure or peripheral pulse display. It also provides variable heart rate alarm limits, three sweep speeds, and ac or internal battery operation.

Standard 412 Monitor **$2700**

Accessories for 408, 412, 413A and 414 Monitors

ORDERING INFORMATION

PATIENT CABLES

Torso Cable (3 electrodes)—
(012-0445-00) **$35**

Torso Cable for 413A (3 electrodes)—
(012-0739-00) **$55**

Electrode Wires for Patient Cables
18 inch wires with snap fittings for disposable electrodes, set of three.
(012-0502-00) **$10**

18 inch wires with No. 4-40 tapped fittings—
White (RA) (012-0449-00) **$9**

Black (LA) (012-0450-00) **$9**

Red (LL) (012-0451-00) **$9**

ELECTRODE ADAPTERS

All equipped with No. 4-40 thread to mate with limb cable or related electrode wires.

Snap Adapter—(103-0110-00) **$2.50**

Needle Adapter—(103-0108-00) **$2**

Plate Adapter—(103-0079-00) **$1**

V-Lead Adapter—(013-0180-01) **$90**

PULSE SENSORS

Finger—(015-0236-01) **$90**

Radial—Best sensor for infants. May also be used for finger, toe, etc.
(015-0237-01) **$90**

TRANSDUCERS

Statham P23 1d—(015-0233-00) **$575**

Trantec 800—(015-0234-00) **$575**

Bell & Howell—4327-I (015-0235-00) **$575**

TEMPERATURE PROBE

YSI 701—For use with 413A or 414.
(118-0256-00) **$50**

MOUNTING FIXTURES

Mounting Kit—Mounts monitor at five foot level. Attached to vertical pipes or surfaces of anesthesia machines or similar devices.
(016-0110-00) **$195**

Support—The upper-most portion of the mounting stand is available separately.
(407-1767-00) **$7**

Mounting Adapter—Attaches to instrument.
(014-0054-00) **$11**

Pole Clamp—Used to mount monitor models 408, 412, 413, 414 on poles ½ inch to 1¼ inch in diameter.
(014-0053-00) **$36**

MISCELLANEOUS

Replacement "D" Cell Battery Set—
(119-0441-01) **$120**

Replacement "F" Cell Battery Set—
(119-0443-01) **$160**

Accessory Pouch—(016-0560-00) **$18**

Servicing Extender Set—408 and 412 only.
(020-0078-00) **$90**

Servicing Extender Set for 414—
(020-0188-00) **$125**

Servicing Extender Set for 413 and 413A—
(020-0291-00) **$200**

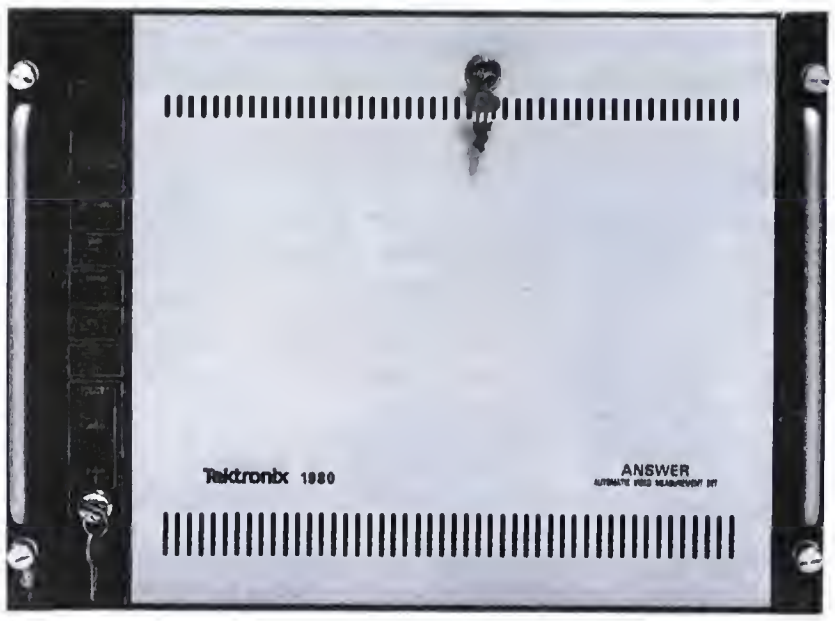
Repair Kit—For No. 4-40 ends on limb cables and electrode wires.
(040-0696-01) **$40**

Television Products

One of our specialties is in the timing, measuring, correcting, and displaying of the television signal. If television is your specialty, too, we invite you to look through our newest edition of the Television Products Catalog. It contains nearly 100 pages of product photos, features, applications, and complete specifications.

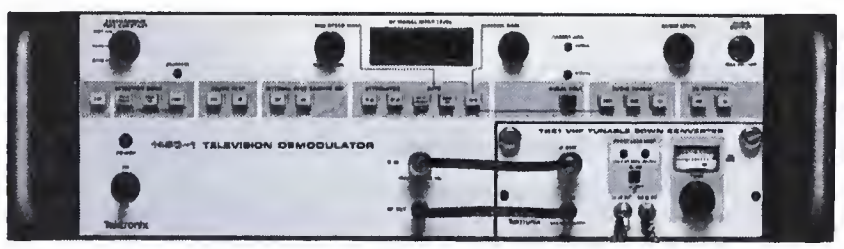
For your copy of the latest Television Products Catalog, call toll free, within the Continental U.S., 1-800-547-1512; or use the response card in this catalog.

Whatever your color standard — PAL, SECAM, or NTSC — Tektronix Television Products will help you deliver the picture quality you want.



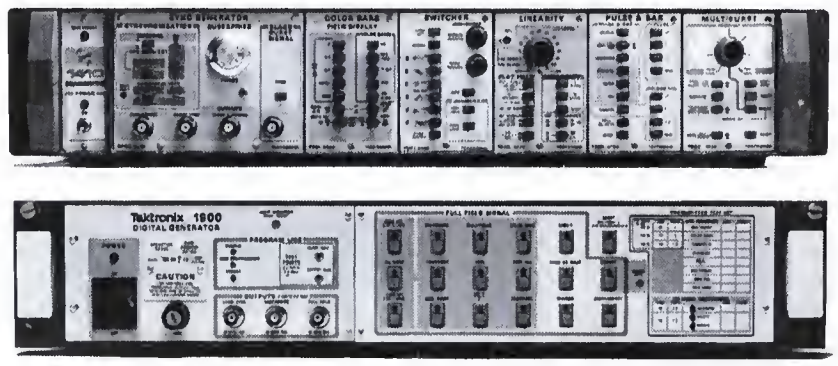
Automatic Video Measurement Set

ANSWER™ is an all digital automatic video measurement set. The Option 01 NTSC applications software will make over 45 amplitude, phase, and timing measurements using FCC and NTC 7 VIT signals. Measurement results are reported in ASCII through an RS-232C interface. The 1980 is phone line compatible and may optionally be interfaced to automatic call equipment. The features of the 1980 make it well suited for either attended or unattended operation. Special requirements may be programmed in Tek ANSWER basic.



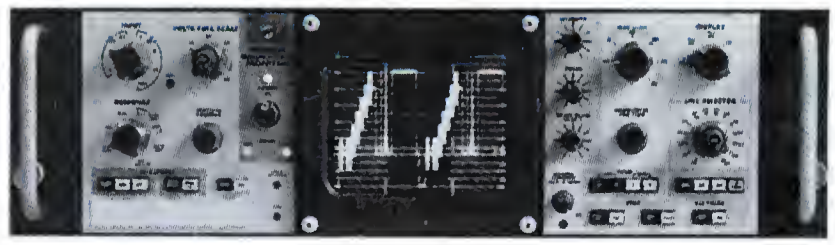
Demodulators—Systems M, B/G

The 1450-1 (System M) and 1450-2 (System B/G) Demodulator Mainframes combine with Tektronix Television Down Converters to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible demodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.



Generators—NTSC, PAL, PAL-M, SECAM

Tektronix Television Signal Generators provide the high quality signals required to accurately time, test, evaluate, and adjust video equipment and systems. Some models, including the new 1900 Digital Test Signal Generator, include VITS insertion and signal processing capabilities. The 1900 also includes new test signals designed to simplify monitor adjustment and frequency response and delay testing.

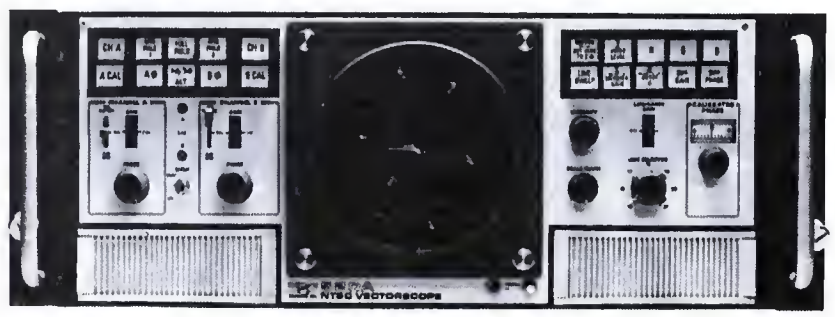


Waveform Monitors—NTSC, PAL, PAL-M, and SECAM

With sync-selective triggering and precise vertical characteristics, TEKTRONIX Waveform Monitors are designed for quick and accurate measurement of video signal components. TEKTRONIX Waveform Monitors can be used with 525/60 and 625/50 scanning standards and for full width or half width rack installation. Cabinet style units are also available.

Color Picture Monitors—NTSC, PAL, SECAM, RGB

In addition to having stable, consistent color characteristics, Tektronix Color Picture Monitors provide underscan and vertical and horizontal delay for detailed examination of the entire picture. A special high resolution Trinitron® CRT and adjustable aperture correction provide consistently high picture sharpness. Isolated differential inputs for encoded/composite or RGB signals, flexible synchronization and unique Blue Only mode permit the 650HR series monitor to meet a variety of needs—both in television systems for displaying and monitoring television picture quality and in special systems where a laboratory quality display is required.



Vectorscopes—NTSC, PAL, PAL-M

Vectorscopes are used to display and measure the video chrominance signal. Chrominance amplitude, chrominance phase, differential phase, and differential gain are included in a wide variety of specialized measurements for which Vectorscopes are used. Some Vectorscopes also offer luminance amplitude measurements and a linear time base display.

The complete reference for data on TEKTRONIX Television Products is the TEKTRONIX Television Catalog. To get it, see the response card in this catalog or call toll free 1-800-547-1512.

Check this catalog for other products used in the video communications industry: sideband analyzers, spectrum analyzers, scopes with sync separation features, and the TM 500 Modular Instruments.

®TRINITRON is a registered tradename of Sony Corporation.

Digital Photometer/Radiometer

J16 Photometer/Radiometer

Digital LED Readout

Freedom from Saturation Effects over Entire Range

Metric and US Versions Available

Accurate Spectral and Cosine Corrections

Internal Rechargeable Batteries

Environmentalized

Eight Silicon Sensor Probes Quickly Interchanged without Recalibration

The TEKTRONIX J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory or in the field.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions.

All probes use silicon photo-diodes and multi-element glass filters for maximum stability and accuracy. The excellent stability eliminates the need for routine zero adjustments.

Integrated circuits are used extensively in the J16 to achieve stable operation, low power requirements, small size, and light weight.

Under normal usage, internal rechargeable nickel cadmium batteries will only need recharging weekly. A battery charger is supplied. For continuous operation, an ac power supply is available which replaces the battery pack.

A shoulder strap provides carrying ease. The cabinet and probes have a standard threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

J16 CHARACTERISTICS

Display — 3½-digit LED readout and three LEDs automatically indicating correct units for probe in use.

Stability — Within 2% per year.

Linearity — Within 2% over the entire range, enabling single point calibration.

Integration Time — Approximately 100 milliseconds.

Calibration — Electrical calibration of the J16 is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

Power Requirements — Internal rechargeable NiCd batteries only need recharging weekly in normal usage. Two hours of continuous operation is provided. (A battery charger is supplied.) For continuous operation, an ac power supply is available. This is interchangeable with the battery pack.

J6511 and J6501 Illuminance Probes

The J6511 is an illuminance probe with readout in footcandles or lumens/m² (lux) (J6511 opt 02). A multi-element glass filter and silicon photo-diode insure a close match to the CIE photopic curve (color corrected). The silicon-senor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

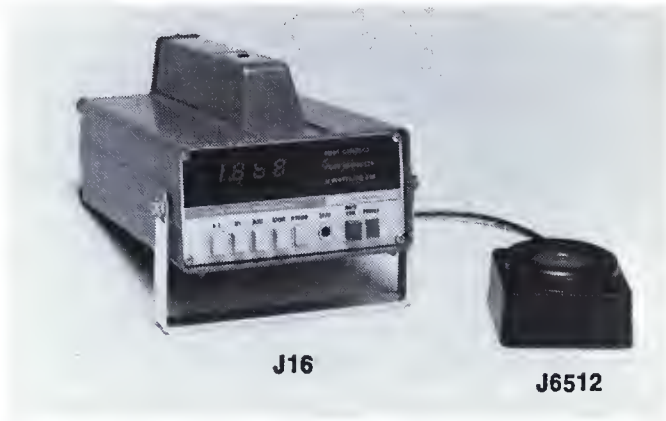
A 25-foot cable between the probe and J16 allows the user to be out of the field of view while making measurements. Typical applications include measurement of roadway illumination, office lighting, and illumination of work surfaces. Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction as the J6511.

J6502 and J6512 Irradiance Probes

The J6502 measures irradiance in microwatts/cm² or millwatts/m² (J6502 opt 02). The spectral response is flat from 450 to 950 nanometers, ±7%. The response is typically down 50% at 400 and 1030 nm. Typical applications include laser research experiments and measurements of radiant efficiency.

An optional filter holder is available to mount standard 1-inch diameter customer-supplied filters of up to ⅜ inch thickness. Where high intensity sources are used (over 1990 μWatts/cm²), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.) held with optional filter holders.

Where the 1 sq cm sensor is not completely filled by the source for example with a laser beam, the reading obtained represents μWatt instead of μWatts/cm² (J6502), or milliwatts x 10^{-4} instead of milliwats/m² (J6502 opt 02). Small variations in sensor area can add ±5% uncertainty to this measurement.



A low-profile version of the probe (J6512), physically similar to the J6511, is available for use where space is restricted.

J6503 8° Luminance Probe

The J6503 measures luminance in footlamberts or candelas/m² (nit) (J6503 opt 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface. Typical applications include measuring brightness of television screens and street signs, and light reflected from work surfaces and movie screens.

Luminance Measurement of a Monitor with J16/J6503.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 12 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (J6503 opt 02) indicator automatically lights when the J6503 is connected.

J6523 1° Luminance Probe

The J6523 will measure the luminance in footlamberts (candelas/m² for the J6523 Opt 02) of a spot as small as 0.32 inches in diameter (0.035 inches with a standard +10 diopter, 55 mm photographic close-up lens). The 1° angle represents 0.21 inches per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1-inch diameter spot. Typical applications include measuring highway lighting, television displays and photographic equipment.

The probe includes an optical sighting system with a 9° viewing field. The focusing range is 18 inches to infinity, closer with commercially available close-up lenses. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources.

The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard ¼-20 threaded socket allows it to be used on a tripod or an optical bench.

J6504 Uncorrected Probe

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters. The J6504 is useful for checking light sources used in photoresist or photoprocessing applications and comparisons of ultraviolet light sources.

A HOLD switch allows the reading to be stored at any time. No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

J6505 LED Test Probe

The principal application of the J6505 is measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 to 710 nm). The J6505 measures illuminance in footcandles or lumens/m² (lux) (J6505 opt 02), which can easily be converted into luminous intensity in candelas.

An adapter supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adapter excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adapter to fit common sizes of LED's (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adapter in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (opt 02), 1 lumen/m² represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 to 710 nm. This close match requires compromising in the 380 to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the adapter must be used with the J6501 and the same conversion factor for luminous intensity applies.

Measuring Luminance with the TEKTRONIX J16/J6523.

Digital Photometer/Radiometer

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Nonoperating, −50°C to +75°C; operating, −15°C to −40°C.

Altitude — Nonoperating, to 50,000 feet; operating, to 15,000 feet

Humidity — Operating and storage, 5 cycles (120 hours) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

Vibration — Operating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inches p-p (4 g's) from 10 to 55 to 10 Hz in 1 minute cycles Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.

DIMENSIONS & WEIGHTS

With probe and battery pack installed.

Dimensions	in	cm
Height	2.4	6.0
Width	4.6	12.3
Length	8.0	20.3
Weights (approx)	**lb**	**kg**
Net	3.3	1.5
Domestic Shipping	5.0	2.3
Export-packed	10.0	4.5

INCLUDED ACCESSORIES

For Battery Operated J16 — battery pack, battery charger, shoulder strap, manual.

For Ac Operated J16 — Ac power supply, shoulder strap, manual.

PROBES

Probe with Option 02 required for metric readout Option 02 J16s. No additional charge.

J6501, Illuminance Probe **$435**
J6502 Irradiance Probe **$420**
J6503 8° Luminance Probe **$420**
J6504, Uncorrected Probe **$420**
J6505, LED Probe, includes LED adapter **$500**
J6511, Illuminance Probe, cosine corrected **$440**
J6512 Irradiance Probe **$470**
J6523 1° Luminance Probe **$1250**

OPTIONAL ACCESSORIES

Actual spectral curve of any probe is available on initial order, at additional cost of Option 05 ..**Add $80**

42 inch Probe Extender Cable — connects J16 and probe.
Order 012-0414-02 .....**$90**

Spare Battery Pack —
Order 016-0539-01 .....**$123**

Cables up to 30 ft in length Available on special order

Analog & BCD Output ....Aavailable on special order

Light Occluder — for TV color monitor balancing.
Order 016-0305-00 .....**$20**

Filter Holder — mounts one-inch diameter filters, of up to ⅜ inch thickness, to probes (except J6511, J6512, J6514, J6523).
Order 016-0527-00 .....**$20**

LED Adapter — included with J6505—
Order 014-0047-00 .....**$70**

Ac Power Supply — allows J16 to be used without batteries.
Order 119-0404-00 115 V, 60 Hz **$179**
Order 119-0404-01 230 V, 50 Hz **$191**

When ordering a battery pack for your ac-powered J16, also order one of the chargers below.

Battery Charger — 115 V, 60 Hz
Order 119-0375-02 .....**$40**

Battery Charger — 230 V, 60 Hz
Order 119-0375-03 .....**$50**

Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Office or Representative regarding special application requirements.

Please use the return card to request data sheet and application notes describing the use of the J16.

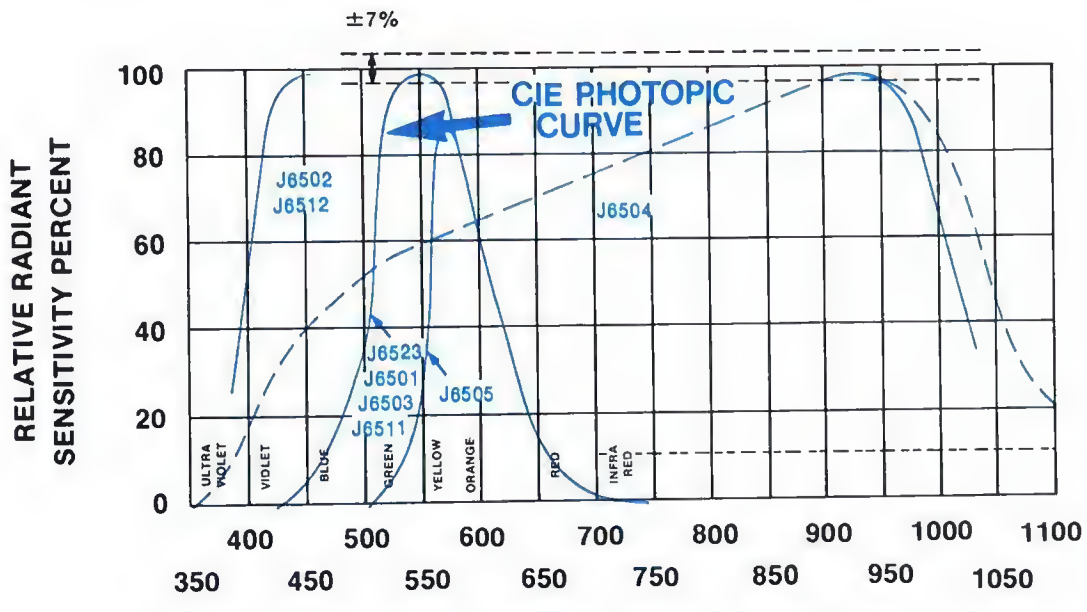
PROBE CHARACTERISTICS

Application		Illuminance		Irradiance	Luminance		Uncorrected	Red LED
Probe		J6501	J6511	J6502/J6512	J6503	J6523	J6504	J6505
Range	US	0.001 to 1999 foot-candles*†	0.001 to 1999 foot-candles*	0.001 to 1999 microwatts/cm²	0.1 to 199,900 foot-lamberts*	0.1 to 19,990 foot-lamberts*	Relative response only	0.001 to 1999 foot-candles*†
	Metric (Opt. 02)	0.01 to 19,990 lumens/m² (lux)*†	0.01 to 19,990 lumens/m² (lux)	0.01 to 19,990 milliwatts/m²*	1 to 1,999,000 candelas/m² (Nits)*	1 to 199,900 candelas/m² (Nits)*	Relative response only	0.01 to 19,990 lumens/m² (lux)*†
Accuracy (Including J16)		Within 5% of NBS standards and ±1 digit in last place Calibrated with a 3100° K tungsten halogen light source traceable to NBS		Same, except calibrated with a 762 nm filter	Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° K tungsten halogen light source traceable to NBS.		Probe-to-Probe accuracy ±5% with tungsten light source	Same as J6501, except calibrated with a 656 nm filter
Spectral Response		Within 2% (integrated) of CIE photopic curve		Flat within ±7% from 450 to 950 nm	Within 2% (integrated) of CIE phototopic curve		UV enhanced silicon spectral curve (250-1200 nm)	Within 2% (integrated) of CIE photopic curve from 600-710 nm
Acceptance Angle		50% sensitivity at 48° off axis	Cosine Corrected (180°)	50% sensitivity at 48° off axis	8 degrees	1 degree	50% sensitivity at 48° off axis	
Stability and Repeatability		Within 2% per year						
Linearity		Within 2% over entire range enabling single point calibration						

*An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.

†0.00001 to 199.9 candelas when used with 014-0047-00 LED adapter or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Foot-candles x d^2 = candelas where d is the distance from the source to the sensor in feet. (For metric readings use lux x d^2 = candelas where d is distance from the source to the sensor in meters.)

TYPICAL PROBE SPECTRAL CHARACTERISTICS



(All curve heights adjusted to 100% for clarity)

ORDERING INFORMATION
Photometer/Radiometer without Probes

Readout Units*	Power Source	Voltage	Order † Information	Price
US	Battery	115 V, 60 Hz battery charger	J16	$890
US	Battery	230 V, 50 Hz battery charger	J16 Opt. 01	NC
US	AC	115 V, 60 Hz	J16 Opt. 03	NC
US	AC	230 V, 50 Hz	J16 Opt. 04	NC

†For a J16 with metric readout, specify Option 02 in addition to above ordering information. No additional charge. Opt. 02 probes are required for Opt. 02 J16's.

*Refer to Readout Units of Probe Characteristics chart.

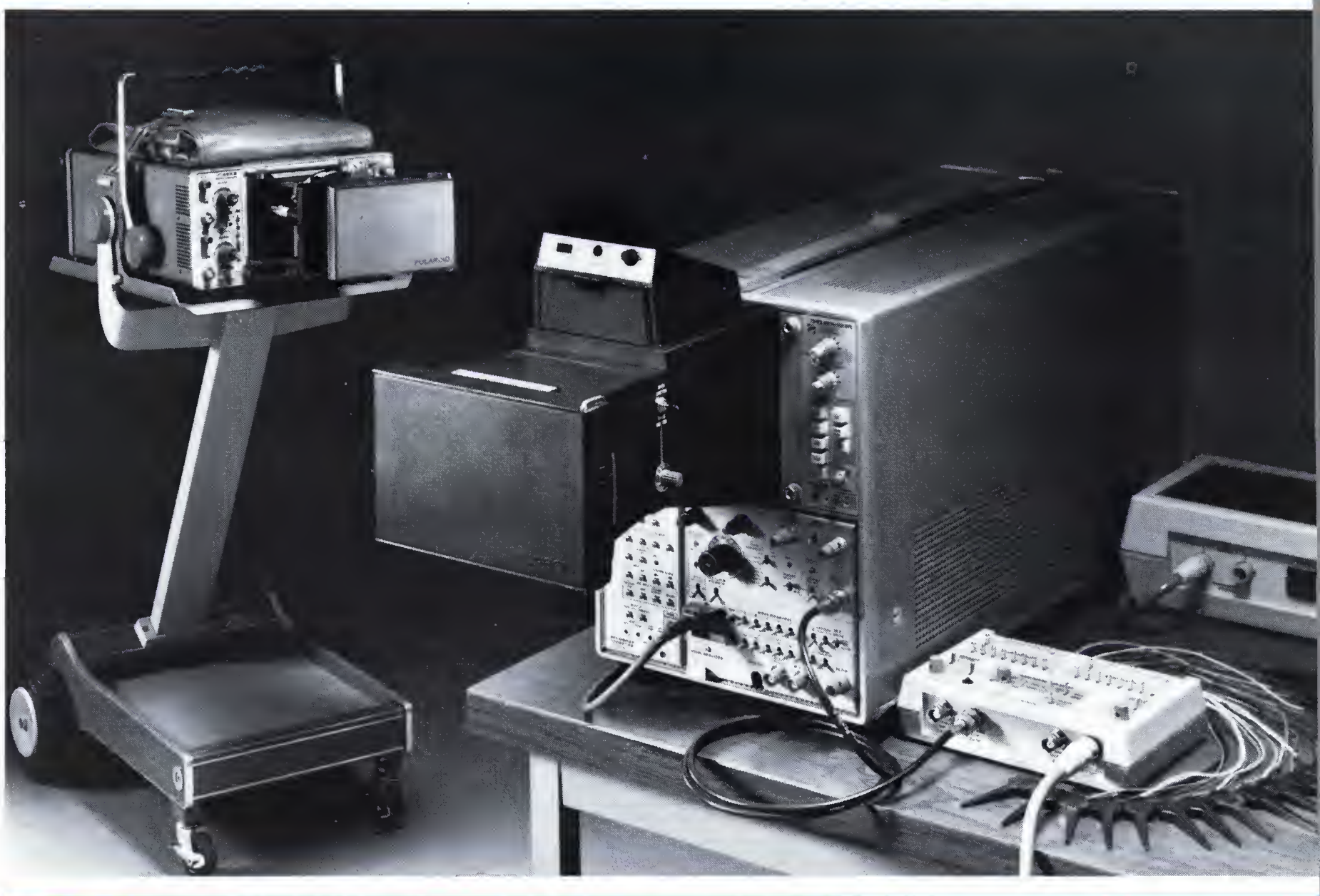
J16-TV Package — for TV color monitor set-up. The package includes J16 Battery-Operated Photometer, J6502 Irradiance Probe, Light Occluder, Probe Extension Cable.

Order J16-TV for 115 V, 60 Hz battery charger ..**$1400**

Order J16-TV Option 01
for 230 V, 50 Hz battery charger .....**NC**

For a J16-TV with metric readout, specify Option 02 in addition to above ordering information. No additional charge.

Accessories



NEW

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Choosing a Tektronix Camera...

an overview of Tektronix Camera Families

A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

MOUNTING

The table on page 265 indicates the camera adapters required for most TEKTRONIX Instruments and a few by other manufacturers. In some cases, adapters are available from Hewlett-Packard or Dumont to mount Tektronix Cameras to their instruments.

LENSES

Tektronix Camera lenses differ mainly in light gathering ability, magnification, and field of view.

Speed—The f-number of a lens inversely signifies its aperture area and light gathering ability. For example. the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in Tektronix Cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C Camera is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

Field of View—The description for each camera includes a statement of its field of view; this signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adapter, camera body, film holder, and the image area of the film.

Magnification — Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most Tektronix Cameras are designed for use at one lens magnification. One exception is the C-30B Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 x 6.3 cm to 8 x 10 cm.

The rated magnification of a lens signifies its image-to-object ratio.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 107 pack film which has an image area of 73 x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film.

SHUTTERS

There are two types of shutters: **mechanical** and **electrical.**

Mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism.

Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

The C-51 and C-53 electric shutters require +15 V, normally supplied by a 7000 Series Oscilloscope. An optional battery pack is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-28 Camera requires +15 volts at 750 mA for operation. The shutter may be actuated with either a switch closure or TTL logic.

VIEWING

Except for the C-30 Series, all Tektronix Cameras have a viewing port which provides a binocular view of the CRT. All Tektronix Cameras, except the C-5C, are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The lightweight C-5C can easily be slipped off the CRT bezel to view the CRT. The C-28 and C-50 Series Cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the CRT display while excluding ambient light.

FILMS

The three types of backs used on Tektronix Cameras accommodate most of the films that are used for CRT trace recording. These include sheet films, roll films, and pack films.

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types.

Many different types of Polaroid film are available in rolls, packs, and 4 x 5 inch single-sheet packets. The types most used in oscilloscope and monitor photography are types 107, 47, 57, 410, 084 and 667.

Technical assistance with Polaroid film and back questions or problems is available directly from The Polaroid Corporation. Call (800) 225-1618 toll free within U.S.

BLACK BODY COLOR STANDARD

All Tektronix Cameras are supplied with a standard black body finish.

Maximum Magnification to Record Entire Screen

	Screen Size			
	5 x 6.3 cm	7.2 x 9 cm	8 x 10 cm	9.76 x 12.2 cm
Polaroid pack and roll film	1.0	1.0	0.85	0.67
4 x 5 sheet film	1.0	1.0	1.0	0.85 or less
6 x 7 cm format roll film (70 mm, 120, 220, etc.)	1.0	0.67	0.67	not recommended

0.5 magnification is used for high speed recording, since reducing the size of image increases its brightness.

PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The TEKTRONIX Writing Speed Enhancer is designed to fill this need.

The Enhancer installs in minutes, and can be triggered in three ways: by a pushbutton on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x sync switch); or by the oscilloscope-sweep + gate.

Thus, the film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, post-fogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the Enhancer with the oscilloscope-sweep + gate.

This Polaroid Type 107, 3000 speed pack film was exposed to the single-trace display of a pulse waveform with a last rising leading edge too dim to produce a developable image.

Film from the same pack was exposed to the same single-trace waveform and simultaneously to light from a Writing Speed Enhancer. The Enhancer light supplied the additional photons needed at the weak film development centers formed by the dim leading edge, to produce a visibe image of the entire waveform.

Polaroid Film		Relative Film Writing Speed	
ASA Equivalent Speed	Type	Unfogged	Fogged
3,000	107 084 47	1 (Reference)	3
10,000	410	2	4

The more commonly used films for each type of camera back are listed below.

POLAROID FILMS

Film Type	ASA Equivalent Speed	Development Time (Seconds at 75° F)	Format	Resolution (Line Pairs/mm)	Characteristics	CRT Recording Uses: Repetitive	Stored	TV Type (Gray Scale)	Scintillation Type Medical	Graphics Alpha-Numeric	Single Sweep
PACK FILMS 3¼ x 4¼ in. — Actual image size 7.3 cm x 9.5 cm											
611*	200	45	Positive Print	20	Low Contrast, wide gray scale			X			
665	75	30	Positive Print Negative	20-25 160-180	Medium Contrast, wide gray scale	X	X	X			
107	3000	15	Positive Print	20	Medium Contrast	X	X				X
084**	3000	15	Positive Print	20	Medium Contrast	X	X	X	X		
667*, **	3000	30	Positive Print	16	Medium Contrast	X	X	X	X		
108*	75	60	Positive Print	15-17	Color—Balanced for 5500° K	X		X			
668*	75	60	Positive Print	15-17	Color—Balanced for Electronic Flash	X		X			
ROLL FILMS 3¼ x 4¼ in. — Actual image size 7.3 x 9.5 cm (46L and 146L are 6.2 x 8.3 cm)											
42	200	15	Positive Print	25-28	Medium Contrast, wide gray scale	X	X	X			
47	3000	15	Positive Print	20-22	Medium Contrast	X	X				X
410	10,000	15	Positive Print	20	High Contrast						X
46L	800	120	Positive Trans	35-40	Medium Contrast	X	X	X			
146L	200*** 100 Tungsten	30	Positive Trans	40-50	High Contrast, Blue Sensitive	X				X	
SHEET FILMS 4 x 5 in. — Actual image size 8.9 x 11.4 cm											
51	320*** 115 Tungsten	15	Positive Print	28-32	High Contrast, Blue Sensitive					X	
52	400	15	Positive Print	35-40	Medium Contrast, wide gray scale	X	X	X			
55 55 P/N	50	20	Positive Print Negative	22-25 160	Medium Contrast, wide gray scale	X	X	X			
57	3000	15	Positive Print	20	Medium Contrast	X	X			X	X
58*	75	60	Positive Print	15-17	Color—Balanced to 5500° K	X		X			

*No coating required.
**Preferred for oscilloscope photography.
***Daylight rating.

Recommended Cameras

Where two or more cameras are recommended, compare features and specs to optimize for your application.

OSCILLOSCOPE OR DISPLAY DEVICE	SINGLE SHOT OR LOW REP RATE	STORED, STABLE OR REPETITIVE	LOW COST
453, 453A, 454, 454A, 485, 491, 422	C-31B	C-30B	
455, 465, 465B, 468, 475, 475A, 432*, 434, 464, 466	C-31B	C-30B	C-5C
7104, 7313, 7503, 7504, 7514, 7613, 7623A, 7633, 7704A, 7904, R7903, 7834, 7844, 492, 606A, 607A	C-51	C-53 C-30B	C-5C
528, 577, 601, 602, 603, 603A, 604, 604A, 605, 608, 624, 634, 1420 Series, 1500 Series, 5403/D40, 5403/D41, 5440, 5441, 5444, 7403N, 7603,7603N11S, T922R. Telequipment D83		C-28* C-59A C-30B	C-5C
T912, T921, T922, T932, T932A, T935, T935A			C-5C
305, 314, 326, 335, 1502, 1503, (SC 502, SC 503, SC 504)		C-30B	
503, 504, 530/540/550 Series, 575, 647, 647A		C-53	
520A, 521A, 522A, 576, 1480 Series		C-59A	
576, 5031, 5032[10]		C-59A	
502A, 529, 565		C-59A C-30B	
HP 5" Round CRT		C-53	
HP 8x10 cm rectangular CRT; except 1740A and 1741A		C-53 C-30B	
HP 1700 Series		C-30B	
Philips 8x10 cm portables			C-5C
HP 1332A, HP1333A, HP1335A		C-59A C-30B	C-5C

*Note: The C-28 Camera is intended for, and particularly suited to, 600 Series OEM measurement applications. Contact your Tektronix Representative for information.

[1]Graticule is nonilluminated and will not photograph.

[2]Graticule is nonilluminated and will not photograph except when CRT is in the stored mode.

[3]Increases camera's field-of-view so that the full 8 x 10 cm CRT display area can be recorded.

[4]C-51 and C-53 Cameras require Battery Pack 016-0270-02 for power when not used with 7000 Series Oscilloscopes.

[5]Available from Hewlett-Packard. See HP catalog for additional compatability information and prices.

[6]Only the C-5C and C-59A Cameras can entirely record the 6½ inch CRT display without cropping.

[7]The C-59A is suitable for the standard-model Type 603 but it cannot photograph the nonilluminated graticule of the Option 01 Model.

[8]The C-59A also mounts directly onto the Type 604 but it cannot photograph the nonilluminated graticule of the standard model.

[9]Does not mount on scope, must be hand held.

[10]Requires 016-0288-01 adapter and correcter lens.

Adapter part numbers for cameras are available upon request. Contact your local field office for more information.

CAMERA ADAPTER PART NUMBERS & PRICES

014-0045-00	$115	016-0263-00	$62
016-0217-00	62	016-0269-04**	75
016-0223-01	50	016-0295-01	50
016-0224-01	50	016-0299-00	62
016-0225-04	50	016-0301-01***	95
016-0226-01	62	016-0306-01†	70
016-0228-01	78	016-0327-01	150
016-0243-00	62	016-0342-00	205
016-0244-00	62	016-0357-01††	15
016-0248-01	78	016-0358-01†††	15
016-0249-04*	73	016-0359-01††††	15

* (Included with C-50 Series Cameras)

** (Adapter with lens included with C-31B Opt 01 Cameras)

*** (Adapter with lens included with C-30B Opt 01 Cameras)

† (Included with C-30B, C-31B Cameras)

†† (Included with C-5C and C-5C Opt 01 Cameras)

††† (Included with C-5C Opt 03 Cameras)

†††† (Included with C-5C Opt 02 Cameras)

see page 268 for extra viewing doors and flash units

Camera Adapter Selection Guide (by oscilloscope type)

OSCILLOSCOPE TYPE	ADAPTER PART NUMBER		
	C-5C	C-50 SERIES AND C-28	C-30 SERIES
528, 577[2], 601, 602, 603 [6,7], 604A[6,8], 605, 606, 606A, 492, 607A, 608, 624, 634, 1420 Series, 5100 Series[1,8], 5403/D40[8], 5403/D41, 5440[8], 5441, 5444[8], 7104, 7313[2], 7403N[8], 7503, 7504, 7514, 7603[8], 7603-N11S, 7613, 7623A, 7633, 7704A, R7903, 7904, 7834, 7844, T922R, HP1332A, HP1333A, HP1335A, TELEQUIPMENT D83[8]	016-0357-01	016-249-04	016-0248-01
432[1], 434[2], 455, 464, 465B, 466, 468, 475, 475A	016-0359-01		016-0301-01[3]
T900 Series except T922R	016-0358-01		
422, 453, 453A, 454, 454A, 485, 491			016-0306-01
305, 314, 326, 335, 1502[1], SC502[1], SC503[2], SC504			016-0327-01
647, 647A		016-0223-01	
529, 561A, 561B, 564A, 564B, 568		016-0224-01	016-0244-00
502A, 503, 504, 530/540/550 Series, 565, 575		016-0225-04	016-0243-00*
HP 5" Round CRT[1]		016-0228-01	
520A, 521A, 522A		016-0295-01	
1480 Series		016-0342-01	
576, 5030, 5031		016-0288-01	
HP 1700 Series except 1740A, 1741A, 1743A			HP10106-A[5]
HP 8x10 cm Rectangular CRT[1] except 1740A, 1743A			HP10363-A[5] 016-0306-01
HP 1740A, 1741A, 1743A (8x10 cm)			HP10377-A[5]
Phillips 8x10 cm Portables[9]	016-0357-01		
600, 5100, 5400, 7000 Series	014-0045-00 will mount HP 195, 197A Cameras		

*Used with 016-0306-01

High Writing Speed and General Purpose Cameras

The top of the line—C-50 Series.

The three C-50 Series Cameras are designed for use with all TEKTRONIX 7000 Series Oscilloscopes, and can be adapted to fit most 5000 Series Oscilloscopes and 600 Series Display Components. Full selection of film backs, and adjustable film and shutter speeds give you the flexibility you need to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces. X sync connectors allow the camera shutter to trigger the event. And each camera's built-in viewing tunnel lets you see what's on the display even when the camera is in place.

All the C-50 Series Cameras can be ordered for either Polaroid pack or roll film; The C51 and C59A can be ordered with a Graflok-type 4 x 5 inch back. All three backs can easily be removed and interchanged without fogging the film.

C-50 Series Cameras have black body finish.

Fastest Writing Speed

Electronic-Controlled Shutter

Photometer Exposure Aid

Range-Finder Focusing

Automatic Single-Sweep Control

C-51. This camera offers the fastest writing speed of any Tektronix oscilloscope camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to image size. The C-51's electric shutter can operate at speeds ranging from 1/60 to 4 seconds, and offers bulb, time, and single sweep modes by manual or remote control. The single sweep mode, available only on the C-51 and C-53 cameras, automatically opens and closes the shutter as the trace sweeps the screen. This can be especially beneficial for single-shot measurements which cannot be duplicated.

General Purpose Medium Speed

Electronic-Controlled Shutter

Photometer Exposure Aid

Range-Finder Focusing

Automatic Single-Sweep Control

C-53. The C-53, like the C-51, provides an 8x10 cm field of view when used with Polaroid pack or roll film. Its f/1.9 lens and 0.85 magnification, however, offer somewhat slower writing speed. This camera's electric shutter also offers speeds ranging from 1/60 to 4 seconds, and can be operated manually or remotely in bulb, time, or single sweep mode. Range-finder focusing, a feature the C-53 shares with the C-51 and the C-59A, results in sharp, focused pictures every time.

High Writing Speed and General Purpose Cameras

- Low-Cost
- Photometer Exposure Aid
- Range-Finder Focusing
- Internal Battery Power
- For Larger CRT'S

C-59A. If you need a camera with an expanded field of view, the C-59A may be the answer. This camera is designed for crts up to 6½ inches, and has a 10.2x12.7 cm field of view with Polaroid pack or roll film. It is the only camera for the 576 Curve Tracer, and the only C-50 Series Camera for the 7603 Oscilloscope. The f/2.8 lens means slow writing speed, but it also means economy. The C-59A's mechanical shutter, operating between 1/50 and 1 second, also contributes to its low cost. Still, many of the features of the higher-priced C-50 Series Cameras are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb and time operating modes, X sync contacts, and film back interchangeability. An optional Adapter Frame/Corrector Lens expands the field of view to fully cover the 6½ inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030 Series Oscilloscopes. The Corrector Lens reduces the effective magnification of the C-59A from 0.67 to 0.5 so it can record the entire display on Polaroid 3¼ x 4¼ inch film.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-51	C-53	C-59A
FEATURES	Fastest writing speed (at expense of image size)	General purpose for 7000 Series with 8 x 10-cm CRTs** Medium writing speed	General purpose low price. For CRTs up to 6½ inches; Slow writing speed
LENS SPEED	f/1.2	f/1.9	f/2.8
MAGNIFICATION	0.5	0.85	0.67
RELATIVE LIGHT GATHERING ABILITY	3.0	1.0	0.65
FIELD OF VIEW	8 x 10 cm with Polaroid pack and roll film	8 x 10 cm with Polaroid pack and roll film	10.2 x 12.7 cm with Polaroid pack and roll film
SHUTTER	Electrically actuated, 4 to 1/60 second, plus Bulb and Time. Provides x sync.		Mechanically actuated 1 to 1/50 sec, bulb and time. Provides x sync.

**The C-53 lens records the largest practical image of an 8 x 10-cm crt display on Polaroid pack and roll film.

ADAPTER FRAME/CORRECTOR LENS C-59 CAMERAS

Expands the field of view of the C-59A to fully cover the 6½-inch CRT and adjacent scale-readout characters of the 576 Curve Tracer and 5030 Series scopes. The Corrector Lens reduces the effective magnification of the C-59A to 0.5 so it can record the entire display on Polaroid 3¼ x 4¼ inch film.

Although the camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. However, all but the upper one-fourth of the display can be viewed via the viewing tunnel and the camera can be swung aside to allow a full view of the entire display.

For C-59 Camera, Order 016-0288-01 .....$110

ACCESSORIES FOR GRAFLOK TYPE BACKS (For C-51 and C-59A)

Here are a few of the film holders available for use with the Graflok Backs to allow use of roll film, and Polaroid 4 x 5 inch Film. Order these accessories from the manufacturer or from your local camera store.

RH/10 120 Roll-Film Holder—10 exposures 2¼ x 2¾ inch for 4 x 5 inch Graflok Backs. **(122-0736-01)**

HR/20 220 Roll-Film Holder—20 exposures, 2¼ x 2¾ inch, for 4 x 5 inch Graflok Backs. **(122-0971-00)**

RH/50 70 mm Holder—50 exposure, 2¼ x 2¾ inch, for 4 x 5 inch Graflok Backs only. **(122-0967-00)**

Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5 inch Single Exposure Film Packets. **(016-0201-01)**

Roll film holders are also manufactured by several other companies.

DIMENSIONS AND WEIGHTS WITH FILM BACK ORDINARILY USED

	C-51R		C-53P		C159AP	
	in	cm	in	cm	in	cm
Height	11.5	29.2	11.5	29.2	11.5	29.2
Width	9.8	24.8	7.5	19.1	7.7	19.3
Length	10.8	27.3	10.8	27.3	10.8	27.3
Weight (Approx)	lb	kg	lb	kg	lb	kg
Net	9.5	4.3	7.5	3.4	7.0	3.2
Shipping	15.0	6.8	12.0	5.4	11.0	5.0

Included Accessories—Focus Plate for Polaroid pack film (387-0893-02), or focus plate for Polaroid roll back (387-0893-01), or focusing screen integral with Graflok type back; mounting adapter for all 7000, 5000, and small 600 Series (016-0249-04)

ORDERING INFORMATION

"P" Models accept Polaroid pack film.

"R" Models accept Polaroid roll film.

"G" Models have Graflok type backs that accept 4 x 5 inch sheet film holders or roll film holders.

C-51

C-51G CAMERA $1630
C-51P CAMERA $1630
C-51R CAMERA $1630

C-53

C-53G CAMERA $1340
C-53P CAMERA $1340
C-53R CAMERA $1340

C-59A

C-59AG CAMERA $950
C-59AP CAMERA $950
C-59AR CAMERA $950

OPTIONAL CAMERA ACCESSORIES

Mounting Adapters—see table on page 265.

Battery Pack—Provides an auxiliary + 15 V power source for the C-50, C-51, C-52, and C-53 with oscilloscopes that don't provide camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000 Series Oscilloscope or an external + 15 V source. Net weight of pack, including batteries, is 1.2 lb. Batteries are not included.
Order 016-0270-02 .....$250

Writing Speed Enhancer—Provides automatic controlled film fogging to increase writing speed by about 3 times for 3000 ASA film and about 2 times for 10,000 ASA film. Installs in minutes.

Writing Speed Enhancer for C-51 Camera.
Order 016-0279-01 .....$235

Writing Speed Enhancer for C-53 Camera.
Order 016-0300-01 .....$263

Writing Speed Enhancer for C-59A Camera.
Order 016-0290-01 .....$263

Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.
Order 122-0926-01 .....$146

Polaroid Roll Film Back—Accepts Polaroid roll film. Included with "R" models.
Order 122-0929-00 .....$191

Graflok Type Film Back, 4 x 5 in—Accepts Polaroid 4 x 5 in film holder, standard cut-film holders, film-pack adapters, roll-film holders (except heavy motorized models). Included with "G" models.
Order 122-0931-01 .....$191

Carrying Case—Holds a complete C-50 Series Camera with extra film-backs and accessories.
Order 016-0177-00 .....$230

Low Cost Camera

C-5C

Easy to Use	Modular Versatility
Low Cost	Electric Shutter
Graticule Illumination	Improved Lens

The C-5C is a low-cost general-purpose camera with Polaroid Pack-film back and a graticule illuminator. It is lightweight, modular, and may be assembled with one of three interchangeable adapter hoods that fit most TEKTRONIX Oscilloscopes and small monitors.

All three adapter hoods have an opening in the top for a lift-up viewing door or a Xenon flash unit for illuminating the CRT graticule. The flash unit has a flipdown viewing door.

Lens—Three element lens with improved focus uniformity. 0.67 or 0.85 magnification selectable by user. The fixed f/16 aperture provides a wide depth of field and eliminates need for adjustable focus.

The f/16 lens has a relatively low light-gathering ability of 0.02 and is not recommended for photographing single-sweep waveforms.

Shutter—Electric with timed speeds from 0.1 to 5 seconds plus open shutter mode.

Graticule Illumination—Variable intensity Xenon flash, triggered by shutter opening, evenly illuminates the CRT screen to backlight non-illuminated graticules.

Recommended Film—Type 107, 3000-speed pack film.

Field of view—0.67 mag—9.8 x 12.2 cm, 0.85 mag—8 x 10 cm.

Power Source—(4) AA batteries, not included.

Body color—Black

Special pricing, terms and conditions are available to OEMS. Contact your local Tektronix representative for complete information.

ACCESSORIES

ADAPTER HOODS (requires assembly with door or flash listed below)

Included with the C-5C and C-5C Option 01 Cameras.
016-0357-01 ..... **$15**

Included with the C-5C Option 02 Camera.
016-0359-01 ..... **$15**

Included with the C-5C Option 03 Camera.
016-0358-01 ..... **$15**

VIEWING DOOR Fits all three adapter hoods. Mounting screws included. Included with C-5C Opt 01 and Opt 02.
016-0630-00 ..... **$5.50**

FLASH UNIT Fits all three adapter hoods. Mounting screws included. Included with C-5C and C-5C Opt 03.
016-0642-00 ..... **$120**

Dimensions	in	cm
Height	5.5	14
Width	6.6	16.8
Length	10.1	25.7
Weights (approx)	**lb**	**kg**
Weight	3	1.4
Net Shipping	4.1	1.9

Order	For Use With	Adapter Hood (Included) Part Number	Flash Unit Included	Price
C-5C	577, 600 Series with unilluminated graticule 1420 Series, 5100 Series	016-0357-01	Yes	**$425**
C-5C Opt 01	528, 600 Series w/o graticule, or with illuminated graticule, 5400 Series, 7000 Series, T922R, TELEQUIPMENT D83	016-0357-01	No	**Sub $40**
C-5C Opt 02	432, 434, 455, 464, 465B, 465M, 466, 475, 475A	016-0359-01	No	**Sub $40**
C-5C Opt 03	T900 Series except T922R	016-0358-01	Yes	**NC**

OEM Camera

C-28

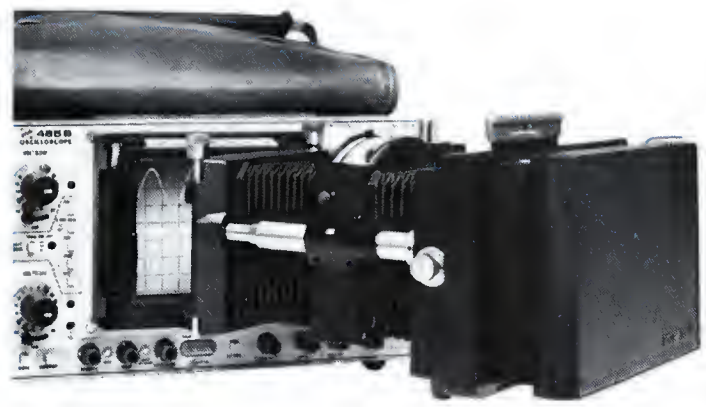
Trapezoidal Distortion Eliminated

Easy Operation

UL 544 Component Recognition

The C-28 is a high-quality recording camera for systems displaying XY, YT or gray-scale images. It is highly recommended for those using TEKTRONIX 600 Series Display Monitors. It features an f/2.8 lens with user-changeable 0.67 and 0.85 magnification ratios to record images from 8 x 10 or 10 x 12 cm CRT's. Other magnification ratios are also available as options.

The C-28 shutter is electronically controlled to provide reliable, repeatable operation and to allow remote control by the user's system. Either a TTL low logic level or a switch closure will actuate the shutter. The C-28 has a highly rigid camera body, allowing the use of heavier accessories such as 70 and 90 mm motorized rollfilm backs without "keystone" distortion or defocusing. The Polaroid 3¼" x 4¼" film back is easily removed, leaving a Graflok-type interface for Graflok-compatible accessories. The film back can be rotated to allow prints to be pulled to the left, to the right, or downward. Optional range-finder focus lights allow quick focusing without removing the film. The C-28 uses the same mounting adapters as C-27 and C-50 Series. The customer must provide a separate 15 V dc 750 mA power supply. A connector and an 18 inch power-cable assembly is included.



C-30B/C-31B

Adaptable to Many Instrument Types

Interchangeable Film Backs

The C-30B and C-31B Cameras are primarily designed for use with the 400 Series Portable Oscilloscopes, but are also adaptable to 8 x 10 cm CRT or smaller 7000, 5000, and 600 Series instruments, and to some others. See chart on page 265. The C-30B has variable magnification, permitting it to make use of the entire photo frame even with different CRT sizes. The C-31B is designed for maximum writing speed (at the expense of image size).

Option 01 is designed to fit the 455, 464, 465, 465B, 466, 475 and 475A. The standard C-30B or C-31B fits the 485.

Camera	Lens Speed	Magnification	Relative Light Gathering Ability	Field of View
C-30B	f/1.9	0.7 to 1.5	1.0	8 x 10 cm
C-31B	f/1.3	0.5	2.7	8 x 9 cm

Shutter—Mechanically actuated, with speeds from 1 to 1/125 s plus bulb and time. Provides x sync switch closure for arming oscilloscope single sweep or initiating the event of interest.

Recommend for—485. See page 265 for compatibility with other instruments. Also see Option 01.

Included Accessories: Split-image focusing plate for Polaroid pack back (387-0893-02); or for Polaroid roll back (387-0893-01); mounting adapter for 485 size bezel (016-0306-01).

Dimensions	C-30BP		C-31BR	
	in	cm	in	cm
Height	5.1	13.0	5.5	14.0
Width	7.5	19.1	9.1	23.1
Length	10.4	25.4	10.6	26.9

Weight (approx)	lb	kg	lb	kg
Net	4.8	2.2	6.8	3.1
Shipping	9.0	4.1	11.0	5.4

SPECIFICATIONS

Shutter Speeds: 1/50, 1/25, 1/10, 1/5, 1/2, 1 sec, and 2 secs within 20%. B (bulb) and shutter OPEN position are also provided.

UL 544 Component Recognition—for use in UL approved medical/dental equipment.

Dimensions

Height: Without viewing tunnel hood, 20.5 cm (8.06 in)

Width: 18.5 cm (7.25 in)

Length: 24.6 cm (9.7 in) maximum with Polaroid pack film lower, mounting adapter, and focus set at maximum extension

Body color—Black

Environmental

Temperature range for specified performance: 0°—50°C

Altitude: 4500m (15,000 ft) operating 15,000m (50,000 ft) non-operating

Weight: 3.8 kg (8.5 lb) with film pack and adapter

Standard Accessories—*Shown with viewing tunnel removed.*

6 pin connector and 18 inch power and control cable assembly 131-1794-00, Polaroid pack film holder 352-0505-01, viewing tunnel and hood 122-0719-01.

ORDERING INFORMATION

C-28 Camera **$1325**

Opt. 01 with Focus Lights . . . . . **Add $50**

Opt. 02 with Graflok Focus Screen and Hood, 122-0510-00 and 122-0944-00 . . . . . **Add $100**

Opt. 03 without Polaroid Film Back 352-0505-01 . . . . . **Subt. $50**

Opt. 04 0.8 Magnification Only . . . . . **Add $40**

Opt. 05 0.9 Magnification Only . . . . . **Add $40**

Opt. 06 Unity Magnification Only . . . . . **Add $40**

Opt. 08 with 016-0249-04 Adapter for 600, 7000, and 5000 Series . . . . . **Add $60**

Special pricing, terms and conditions are available to OEMS. Contact your local Tektronix representative for complete information.

ORDERING INFORMATION

"P" Models accept Polaroid pack films.

"R" Models accept Polaroid roll films.

C-30B

C-30BP CAMERA **$1050**

C-30BR CAMERA **$1050**

C-31B

C-31BP CAMERA **$1210**

C-31BR CAMERA **$1210**

OPTIONS

C-30B Opt 01 Expanded Field of View—f/1.9, 0.8 magnification lens covers 8 x 10 cm CRT screen without vignetting. Relative light-gathering ability is 0.9. Includes 016-0301-01 adapter for 465 size CRT bezel. Recommended for—455, 464, 465, 465B, 466, 475, 475A.

Specify Option 01 . . . . . **Add $25**

C-31B Opt 01, Expanded Field of View—f/1.2, 0.5 magnification lens with relative light gathering ability of 2.9 covers CRT screens up to 8 x 10 cm. Includes 016-0269-04 adapter for 465 size CRT bezel. Recommended for—455, 464, 465, 465B, 466, 475, 475A.

Specify Option 01 . . . . . **Add $25**

CONVERTING OPT 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the Corrector Lens, removing the Adapter Frame, and adding an 016-0306-01 Adapter. Please refer to page 265 for prices and compatibility.

CONVERTING STANDARD MODEL TO OPT 01 MODEL

A standard-model C-30B or C-31B can be converted to an Option 01 model by means of the appropriate Adapter Frame/Corrector Lens: 016-0301-01 for C-30B; 016-0269-04 for the C-31B. Please refer to page 265 for prices and compatibility.

OPTIONAL ACCESSORIES

Mounting Adapters—See Page 265.

Writing Speed Enhancer—Increases effective film speed about 3 times for 3000 speed film or about 2 times for 10,000 speed film. Installs in minutes.

Order 016-0284-01 . . . . . **$235**

Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.

Order 122-0752-01 . . . . . **$160**

Polaroid Roll Film Back—Accepts Polaroid roll film. Included with "R" models.

Order 122-0754-00 . . . . . **$190**

Graflok Type 4 x 5 in Back—Accepts Polaroid Land 4 x 5 in film holders, standard cut film holders, film pack adapters, roll film holders (except heavy motorized roll film holders).

Order 016-0487-00 . . . . . **$210**

Carrying Case—Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 x 14.5 x 8 in.

Order 016-0587-00 . . . . . **$95**

X Sync Cable—
Order 012-0364-01 . . . . . **$18**

C-30A Portra Lens—A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a distance of 21 in. the camera covers 19 x 21 in. Usable with either the C-30B or C-30B Opt 01.

Order 016-0246-02 . . . . . **$28**

Recommended Probes

INSTRUMENT	PROBES			
	PASSIVE		ACTIVE	CURRENT
7000 SERIES				
7A11	Built in FET Probe			P6302/AM503 P6303/AM503
7A13	P6055 P6101 P6060 P6062B	P6015 P6009 P6105		P6021 P6022
7A15A	P6101 P6105 P6062B	P6015 P6009		P6021 P6022
7A16A	P6106 P6101 P6063B	P6015 P6009	P6201 P6202 P6046	P6021 P6022 P6302/AM503
7A18	P6101 P6105 P6062B	P6015 P6009	P6202	P6021 P6302/AM503
7A19	P6056 P6057		P6201 P6202	P6022 P6302/AM503 P6303/AM503
7A22	P6101 P6055 P6060 P6062B			P6021 P6302/AM503
7A24	P6056 P6057		P6201 P6202	P6022 P6302/AM503 P6303/AM503
7A26	P6101 P6106 P6063B	P6015 P6009 P6048	P6201 P6202	P6022 P6302/AM503 P6303/AM503
7A29	P6056 P6057		P6046 P6201 P6202	P6302/AM503 P6303/AM503
5000 SERIES				
5A14N	P6101 P6108 P6062B	P6015 P6007		P6302/AM503 P6021
5A15N	P6101 P6108 P6062B	P6015 P6007		P6302/AM503 P6021
5A18N	P6101 P6108 P6062B	P6015 P6007		P6021 P6302/AM503
5A21N	P6101 P6055 P6060			P6021
5A22N	P6101 P6055 P6060			
5A26	P6101 P6060 P6055			P6021
5A38	P6101 P6105 P6062B	P6015 P6009		P6021 P6022 P6302/AM503
5A45	P6101 P6105 P6062B	P6015 P6009		P6021 P6022 P6302/AM503
5A48	P6101 P6105 P6062B	P6015 P6009		P6021 P6022 P6302/AM503
TM 500 SERIES				
AM 502	P6055 P6060	P6101 P6028		P6021
AM 503				P6302 P6303
DM 501A **DM 502A** **DM 505**	P6420 40 kV (010-0277-00)			
DC 503A **DC 504** **DC 505A** **DC 509**	P6125 P6108			
DC 508A	P6125 P6108	P6056		
SC 501 **SC 502** **SC 503**	P6101 P6028 P6108 P6060	P6062B P6007 P6013A P6015		P6021
SC 504	P6101 P6108	P6062 P6009		P6021 P6022

INSTRUMENT	PROBES			
	PASSIVE		ACTIVE	CURRENT
400 SERIES				
485	P6101 P6106 P6056 P6057 P6063B	P6015 P6009 P6048	P6201 P6202 P6046	P6021 P6022 P6302/AM503 P6303/AM503
475A **475**	P6101 P6106 P6063B	P6015 P6009 P6048	P6201 P6202 P6046	P6021 P6022 P6302/AM503 P6303/AM503
465B **465** **468**	P6101 P6105 P6062B	P6015 P6009 P6048	P6201 P6202 P6046	P6021 P6022 P6302/AM503 P6303/AM503
465M	P6101 P6104	P6015 P6009	P6201 P6202 P6046	P6021 P6022 P6302/AM503 P6303/AM503
455	P6101 P6105 P6062B	P6015 P6009	P6202	P6021 P6022 P6302/AM503 P6303/AM503
466 **464**	P6101 P6105 P6062B	P6015 P6009	P6202 P6201	P6021 P6022 P6302/AM503 P6303/AM503
434	P6101 P6108 P6009 P6015			P6021 P6022 P6302/AM503 P6303/AM503
300 SERIES				
308	P6107		P6406 P6451-05	
314	P6101 P6149			P6021 P6022 P6302/AM503 P6303/AM503
335	P6101 P6149			P6021 P6022 P6302/AM503 P6303/AM503
326	P6101 P6149			P6021 P6022 P6302/AM503 P6303/AM503
323	P6101 P6149			P6021 P6022 P6302/AM503 P6303/AM503
T900 SERIES				
T935A	P6101 P6108 P6062B P6009 P6015			P6021 P6022 P6302/AM503 P6303/AM503
T932A	P6101 P6108 P6062B P6009 P6015	P6006		P6021 P6022 P6302/AM503 P6303/AM503
T922/T922R	P6101 P6108 P6062B P6007 P6015			P6021 P6022 P6302/AM503 P6303/AM503
T921	P6101 P6108 P6062B P6006 P6007 P6015			P6021 P6022 P6302/AM503 P6303/AM503
T912	P6101 P6108 P6062B P6007 P6015	P6006		

Recommended Probes

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source impedance. For higher frequencies (greater than about 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, passive voltage probes offer a wide probe selection for a variety of applications for 1 MΩ inputs.

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6107, P6108, and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes).

VOLTAGE PROBES for 1 MΩ Inputs

MODULAR

Type	Atten	Length*	Package Number		Loading		Useful[5] BW MHz	Dc Max	Scope C in pF	Readout	Page
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	Opt 01 Std Opt 02	1 MΩ	32 pF 54 78	34 15.5 8	500 V	ANY	—	278
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	Opt 01 Std Opt 02	10 MΩ	10.5 pF 13.0 15.5	100 100 95	500 V	15 to 47	YES	278
P6106	10X	1 m 2 m 3 m	010-6106-01 010-6106-03 010-6106-05	Opt 01 Std Opt 02	10 MΩ	10.5 pF 13.0 15.5	300[6] 250 150	500 V	15 to 24	YES	278
P6107	10X	2 m	010-6107-03		10 MΩ	13.0 pF	100	500 V	15 to 47	YES	279
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	Opt 01 Std Opt 02	10 MΩ	10.5 pF 13.0 15.5	100 100 95	500 V	15 to 47	NO	279
P6149	10X	2 m	010-6149-03	Std	10 MΩ	15.5 pF	50	500 V	20 to 62	NO	279
P6125	5X	1.5 m	010-6125-01		5 MΩ	20 pF	200	250 V	≈ 15 to 33	NO	193

VOLTAGE PROBES for 1 MΩ Inputs

MONOLITHIC

Type	Atten	Length*	Package Number		Loading		Useful[5] BW MHz	Dc Max	Scope C in pF	Readout	Page
P6006[1]	10X	3.5 6 9 12	010-0127-00 010-0160-00 010-0146-00 010-0148-00	Opt 01 Std Opt 02 Opt 03	10 MΩ	7.5 pF[2] 8.5 11 13	35 25 25 12	600 V	15 to 55	NO	280
P6007	100X	3.5 6 9 12	010-0150-00 010-0165-00 010-0152-00 010-0154-00	Opt 01 Std Opt 02 Opt 03	10 MΩ	2 pF[2] 2.2 2.4 2.6	25 20 15 13	1.5 kV	15 to 55	NO	280
P6008	10X	3.5	010-0129-00		10 MΩ	7.5 pF	100	600 V	12 to 47	NO	280
P6008 (Environmentalized)	10X	6	010-0129-01	Std	10 MΩ Environmentalized — 50 °C to + 150 °C	7.5 pF	100	600 V	12 to 47	NO	280
P6009	100X	9 9	010-0170-00 010-0264-01	Opt 04 Std	10 MΩ	2.5 pF[2] 2.5	120 100	1.5 kV	12 to 47	NO YES	281
P6010	10X	3.5	Furnished with S-5. For other uses see P6105 or P6106.								
P6015	1000X	10	010-0172-00	Std	100 MΩ	3 pF	75	20 kV	12 to 47	NO	281
P6028	1X	3.5 6 9 12	010-0074-00 010-0075-00 010-0076-00 010-0077-00	Opt 01 Std Opt 02 Opt 03	1 MΩ	50 pF 67 90 112	17 10 7 4	600 V	ANY	YES	282
P6048	10X	6	010-0215-00		1 kΩ	1 pF	100	20 V	15 to 20	NO	281
P6053B	10X	3.5 6 9	010-6053-11 010-6053-13 010-6053-15	Opt 01 Std Opt 02	10 MΩ	9.5 pF 12.5 13.5	200 200 115	500 V	15 to 24	YES	283
P6055[3]	10X	3.5	010-6055-01	Std	1 MΩ	10 pF	60	500 V	20 to 47	YES	282
P6060[3]	10X	3.5 6	010-6060-01 010-6060-03	Opt 01 Std	10 MΩ	7.5 pF[2] 8.5	35 25	600 V	15 to 55	YES[4]	283
P6062B	10X or 1X 10X or 1X 10X or 1X	3.5 6 9	010-6062-11 010-6062-13 010-6062-15	Opt 01 Std Opt 02	10 MΩ 1 M_Ω 10 MΩ 1 m_Ω 10 MΩ 1 M_Ω	13.5 pF 100 14 105 17 135	100 8 100 6 95 4.5	500 V	15 to 47	YES	283
P6063B	10X or 1X 10X or 1X	3.5 6	010-6063-11 010-6063-13	Opt 01 Std	10 MΩ 1 MΩ 10 MΩ 1 MΩ	11 pF 80 14 105	200 12 200 6	500 V	15 to 24	YES	283

Length in feet except where specified.

1. *To convert to uhf connectors, use adapter 103-0015-00.*
2. *Rating varies with scopes having other than 20 pF inputs.*
3. *Designed for use with scopes having differential inputs.*
4. *Not compatible with CRT readout.*
5. *25 Ω source.*
6. *Typically 300 MHz at probe tip with scope bandwidth at least 325 MHz.*
7. *Trace identification button.*

Recommended Probes

Where higher frequencies (above 250 MHz) are encountered, active FET probes which have high input resistance and low input capacitance through their dynamic range should be used. For 50 Ω systems, see adjacent selection chart of 50 Ω divider probes.

FET PROBES

Type	Atten	Length*	Package Number	Loading	Rise time in ns	INPUT LIMITS Max dc + pk ac	INPUT LIMITS Linear Dynamic Range	INPUT LIMITS Dc Offset Range	Read-out	Page
P6046 Diff/Amp	1X	6.0	010-0232-00 Std	1 MΩ 10 pF	3.5	±25 V	±5 V		NO	273
	10X			10 MΩ 3 pF		±250 V	±50 V			
P6201 FET	1X	6.0	010-6201-01 Std	100 kΩ 3 pF	0.4	±100 V	±0.6 V	±5.6 V	YES	273
	10X			1 MΩ 1.5 pF		±200 V	±6 V	±56 V		
	100X			1 MΩ 1.5 pF		±200 V	±60 V	±200 V		
P6202A FET	10X	2m	010-6202-03 Std	10 MΩ 2 pF	0.7	±200 V	±6 V	±55 V	YES	273
	100X		W/010-0384-00Atn	10 MΩ 2 pF	0.7	±200 V	±60 V	±200 V	NO	

For rise time measurements, the interaction of the probe capacitance with the source impedance is of importance (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

50 Ω DIVIDER PROBES—For use with 50 Ω input amplifiers

Type	Atten	Length*	Package Number	Loading	Rise time in ns	INPUT LIMITS Max dc + pk ac	INPUT LIMITS Linear Dynamic Range	Read-out	Page
P6056	10X	6.0	010-6056-03 Std	500 Ω 1 pF	0.1	±16 V	±16 V	YES	274
		9.0	010-6056-05 Opt 2						
P6057	100X	6.0	010-6057-03 Std	5 kΩ 1 pF	0.25	±50 V	±50 V	YES	274
		9.0	010-6057-05 Opt 2						

*Length in feet except where specified.

For measuring currents from dc to 1000 A, see the adjacent selection chart for current probes.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the milliohm to low ohm range. Current probes can be used for differential measurements, where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. To obtain the total picture, a measurement of the current waveform is necessary.

CURRENT PROBES

Type	Bandwidth Hz to MHz	Current/Div Scope at 10 mV/div	Current/Div Scope at Any Sensitivity mA/mV	SATURATION Dc Amps	SATURATION Pulse Amp-S Product	MAXIMUM CURRENT dc + pk ac Amp	MAXIMUM CURRENT ac p-p Amp	MAXIMUM CURRENT Derate Below	MAXIMUM CURRENT Derate Above	MAXIMUM CURRENT Peak Pulse Amp	Page
P6302/ AM503	dc 50	1 mA to 5A		20	$100x10^{-6}$	20	40		1 MHz	50	
P6302/ AM 503 with CT-5	0.5 20	20 mA to 5 kA*			0.1		40 k	20 Hz	1.2 kHz	50 k	275, 276
P6303/ AM503	dc 15	10 mA to 50 A		100	$10,000x10^{-6}$	100	200		20 kHz	500	275, 276
P6021 Passive Term	120 60		2 or 10	0.5	$0.5x10^{-3}$		15	300 Hz	5 MHz	250	277
134	12 38	1 mA to 1A*		0.5	$0.5x10^{-3}$		15	230 Hz	5 MHz	15	
CT/5 Passive Term	120 20		40 or 10 k	20	0.5		2000	300 Hz	1.2 kHz	50 k	
CT-5/134	12 20	20 mA to 1 kA*		20	0.5		2000	230 Hz	1.2 kHz	15 k	
P6022 Passive Term	8.5 k 200		1 or 10	0.2	$9x10^{-6}$		6	3 kHz	10 MHz	100	277
134	100 65	1 mA to 1A*		0.2	$9x10^{-6}$		6	1.3 kHz	10 MHz	15	
CT-1	30 k 1000		5mV/mA	0.2	$1x10^{-6}$		1.4			100	278
CT-2	1.2 k 100		1m/mA	0.2	$50x10^{-6}$		7			100	278

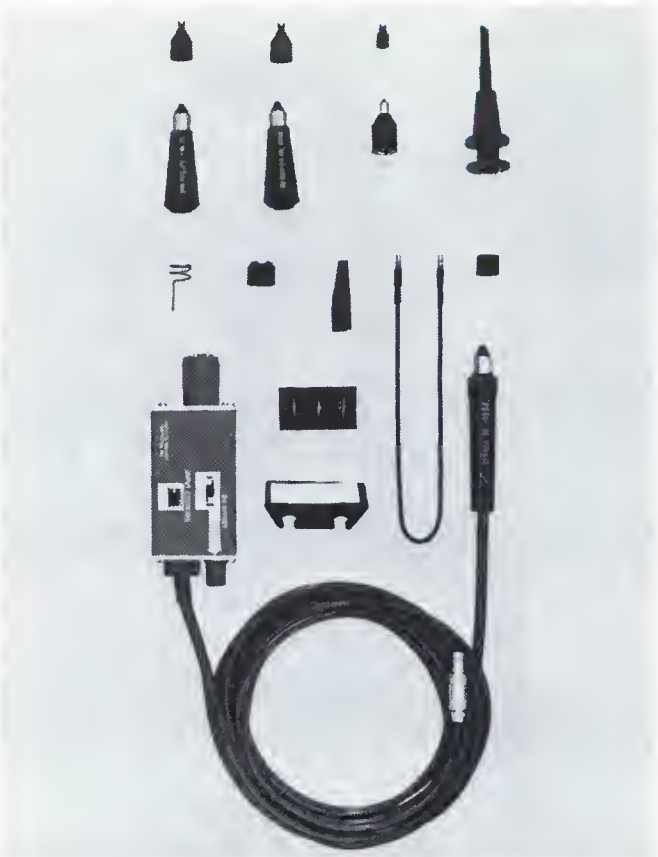
*Scope at 50 mV/div

Recommended Probes—For 7000 Series see page 97, for 5000 Series see page 133, for 400 Series see the individual instrument description.

OTHER PROBES

Probe	Package Number	Function	Use	Page
P6058	010-0260-00	Temperature and Voltage Probe	DM 501A 7D13	188
P6430	010-6430-00	Temperature Probe	DM 44	155
P6104	010-6104-00	Voltage Probe	465M	156
40 kV	010-0277-00	High Voltage Probe	DM 501A DM 502A	186, 188
P6451	010-6451-03	Data Acquisition Probe	7D01	40
P6401	010-6401-01	Logic Probe	TTL Logic	43
P6406	010-6406-03	Word Recognizer	308	31
P6420	010-6420-03	RF Probe	DM 501A DM 502A DM 44	188 186, 274 155
P6601	010-6601-01	Temperature Probe	DM 501A DM 502A	187 —
P6125	010-6125-01	Digital Counter /Timer Probe, 5X Attenuation	DC 503A DC 504 DC 505A DC 508 DC 509	280

P6201 Dc to 900 MHz



- Unity Gain
- Two Plug-on Attenuator Heads that Maintain Scope Readout Factor
- Low Input Capacitance
- Dc Offset
- Ac-Dc Coupling Switch

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

SPECIFICATIONS

Bandwidth — Dc to 900 MHz (– 3 dB). **Rise Time —** 0.4 ns or less. **Probe Gain —** 1X within 3%. **Attentuator Accuracy —** ≤4% with probe (10X and 100X). **Input Impedance —** Probe only. 100 kΩ within 1%, shunted by ≈3.0 pF. Attenuator heads are 1 MΩ within 1%, shunted by 1.5 pF or less. **Dynamic Signal Range —** At least ±600 mV; extended to ±6 V with 10X Attenuator; ±60 V. **Dc Offset Range —** At least – 5.6 to + 5.6 V without attenuator head. Effective offset is extended by 10X and 100X attenuator heads to ± 56 V and ± 200 V, respectively. **Noise —** 300 μV or less at output (measured tangentially). **Maximum Input Voltage —** ± 100 V, probe only; ± 200 V with attenuator heads, derating with frequency. **LF Response —** 10 Hz or lower, – 3 dB, ac coupled; 10X attenuator extends Lf response to ≤ 1 Hz; with 100X attenuator, Lf response is ≤ 10 Hz.

INCLUDED ACCESSORIES

013-0135-00	1 **TIP,** probe, retractable (BT)
010-0376-00	1 **ATTENUATOR** head 10X
010-0377-00	1 **ATTENUATOR** head 100X
206-0200-00	3 **TIP,** probe (CO)
131-1302-00	1 **CONTACT,** ground (CG)
175-0848-02	1 **LEAD,** ground, 12 in (30 cm) (BB)
103-0164-00	1 **TIP,** probe (CD)
344-0046-00	1 **CLIP,** alligator (AU)
166-0557-00	1 **INSULATING SLEEVE,** electrical (CJ)
342-0180-00	1 **INSULATOR,** ground contact (CT)
016-0156-02	1 **CARRYING CASE**

ORDERING INFORMATION

P6201 FET Probe,
Order 010-6201-01 ..... $885

1101 Accessory Power Supply, for powering up to four P6201 Probes.

1101 Probe Power Supply,
Order 1101 ..... $490

P6202A Dc to 500 MHz

- Self-Contained Power Supply
- Dc Offset
- High Input Impedance through Freq Range
- Small Probe Size
- Rugged

With its standard Tektronix power connector the P6202A can be used on any instrument which has standard probe power. The very low input capacitance of the probe permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading.

The probe has a dc offset feature to offset any dc component within the range of the control to bring the signal into the dynamic range of the probe.

SPECIFICATIONS

Probe and (Opt 10X Attenuator Head):
Bandwidth — Dc to ≥ 500 MHz (– 3dB). **Rise Time —** 0.7 ns or less. **Attenuation —** 10X within 4% (100X within 2% for Opt 10X Attenuator Head). **Input Impedance —** 10 MΩ within 2% shunted by ≈ 2 pF. **Dynamic Range —** 0 to ± 6 V. **Dc Offset Range —** – 55 V to + 55 V (– 200 V to + 200 V for Opt 10X Attenuator Head). **Noise** (Tangential) — 150 μV or less. **Max Safe Input Voltage —** 200 V dc + peak ac, derated with frequency.

Opt Ac Coupling Cap:

Bandwidth — 16 Hz to ≥ 500 MHz (– 3dB). **Rise Time —** 0.7 ns or less. **Input Impedance —** ≈ 4 pF. **Max Safe Input Voltage —** 200 V dc + peak ac.

INCLUDED ACCESSORIES

013-0097-01	1 **TIP,** probe, retractable (BO)
352-0351-00	1 **HOLDER,** probe
344-0046-00	2 **CLIP,** alligator (AU)
175-0849-00	1 **LEAD,** ground, 3 in (7.5 cm) (BC)
016-0378-00	1 **CARRYING CASE**
003-0675-01	1 **ADJUSTMENT TOOL,** probe (CU)
175-1017-00	1 **LEAD,** ground, 6 in (13 cm) (BE)
— — — —	2 **TIP,** probe, replaceable*
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)

*Available in package of 10 only, order 206-0230-03 (CR)

ORDERING INFORMATION

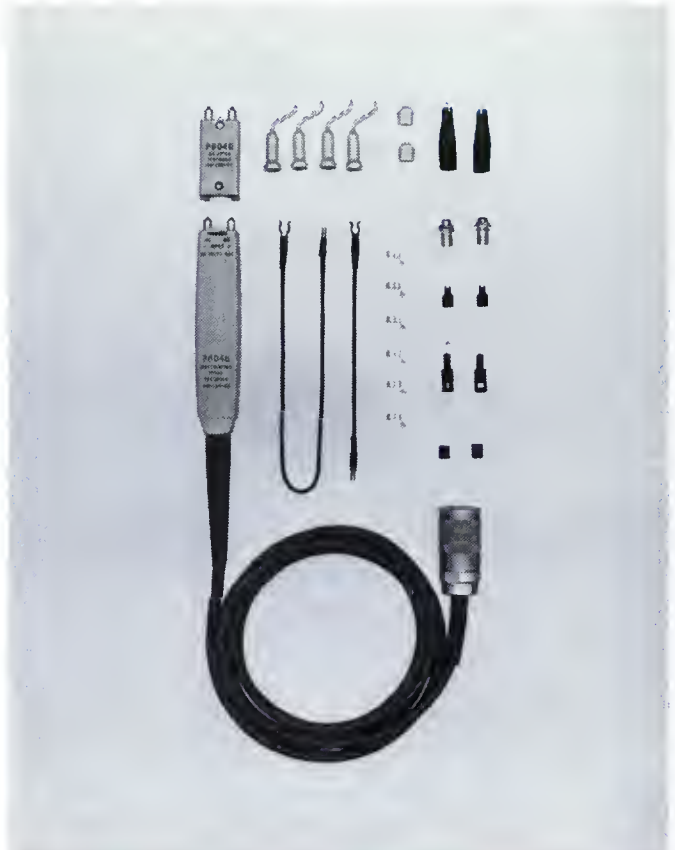
P6202A FET Probe, 2 Meter Cable,
Order 010-6202-03 ..... $500

OPTIONAL ACCESSORIES

P6202A 10X Attenuator,
Order 010-0384-00 ..... $55
P6202A Ac Coupling Cap,
Order 010-0360-00 ..... $27

Included Accessories with double alpha codes are pictured on pages 284 and 285.

P6046 Dc to 100 MHz



- 1000:1 Cmrr at 50 MHz
- ± 250 V Maximum Voltage with 10X Attenuator
- Dual Probe Tips for Greater Cmrr at High Frequencies

The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities with all Tektronix Oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

SPECIFICATIONS

Cmrr — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz. **Common-mode Linear Dynamic Range —** ± 5 V, ± 50 V with 10X attenuator. **Bandwidth —** Dc to 100 MHz (– 3dB). **Rise Time —** 3.5 ns or less. **Deflection Factor Range —** 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). **Input RC —** 1 M Ω paralleled by 10 pF or less. **Input Coupling —** Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is – 3dB at 20 Hz, 2 Hz with 10X attenuator. **Displayed Noise —** 280 μV or less (tangentially measured). **Maximum Input Voltage —** ± 25 V (dc + peak ac), ± 250 V with 10X attenuation, derated with frequency. **Output Impedance —** 50 Ω through a **BNC** connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems. **Probe Cable —** 6 ft. long, terminated with special nine-pin connector. **Amplifier Power Requirements —** 10 W maximum, 48 to 400 Hz. Factory wired for 105 V to 125 V ac (117 V ac nominal) operation. Transformer taps permit operation at 210 V to 250 V ac (234 V ac nominal).

INCLUDED ACCESSORIES

014-0029-00	1 **HANGER ASSEMBLY**
012-0076-00	1 **CABLE ASSY,** Rf (CW)
011-0049-01	1 **TERMINATION,** 50 Ω (BJ)
016-0111-01	1 **CARRYING CASE**

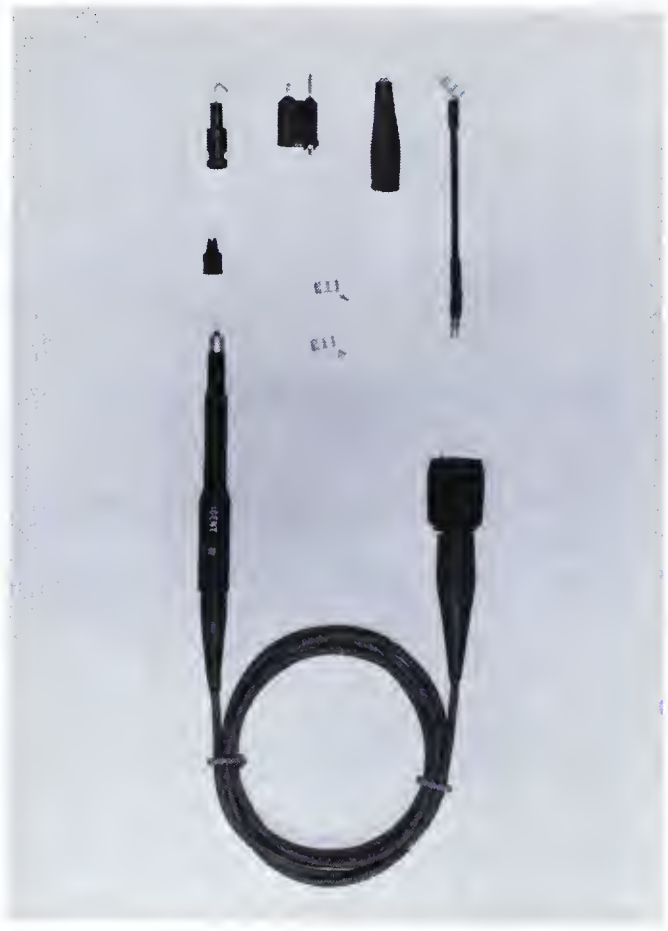
ORDERING INFORMATION

P6046 FET Differential Probe, Amplifier, and Power Supply.
Order 010-0232-00 ..... $1410

Opt 05 w/o Amplifier and Power Supply,
Order 010-0213-00 ..... $735
Power Supply with Amplifier
Order 015-0106-00 ..... $690

RF and 50 Ω Probes

P6056 Dc to 3.5 GHz 10X



50 Ω Probe

The P6056 is a miniature low-capacitance probe for use with 50 Ω wide-band oscilloscopes. Bandwidth is dc to 3.5 GHz. This probe can also be used with 50 Ω sampling systems, with an appropriate BNC adapter. The P6056 is equipped with a special BNC connector that provides trace identification and CRT READOUT information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

SPECIFICATIONS

Bandwidth — 3.5 GHz probe only. **Rise Time** — Less than 100 ps probe only. **Attenuation** — 10X. **Input Resistance** — 500 Ω at dc; ≈ 300 Ω at 1 GHz. **Input Capacitance** — 1.0 pF. **Maximum Input Voltage** — Rf 16 V dc + peak ac derated above 800 MHz decreasing to 9 V at 1 GHz. **Peak Pulse** — Not to exceed 500 V for 1 ms. **Temperature Range** — + 15 to + 55 °C. **Maximum Power Dissipation** — 0.5 W. **Transit Time Variation** — Less than 70 ps probe to probe.

INCLUDED ACCESSORIES

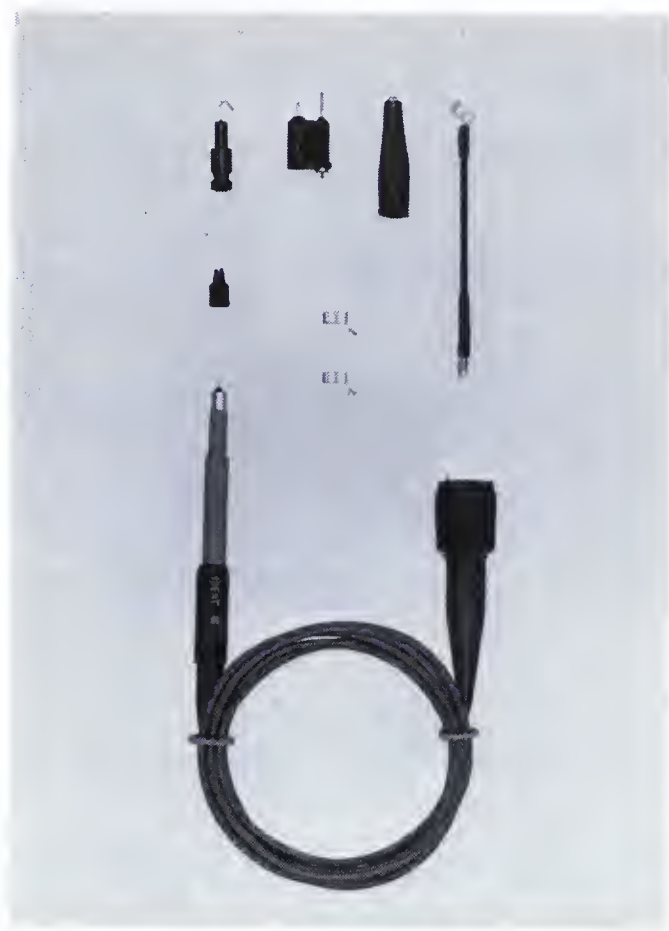
344-0046-00	1 **CLIP,** alligator (AU)
206-0114-00	1 **TIP,** hook probe (CK)
013-0085-00	1 **TIP,** probe, bayonet (BM)
214-0283-00	1 **CONTACT,** electrical (CS)
175-0249-00	1 **LEAD,** ground, 3 in (7.5 cm) (AY)

ORDERING INFORMATION

P6056 10X, 50 Ω Probe, 6 ft., 010-6056-03 . . . . . $120

Opt 02, 9 ft, 010-6056-05 . . . . . $120

P6057 Dc to 1.4 GHz 100X



50 Ω Probe

The P6057 is a miniature low-capacitance probe for use with 50 Ω, wide-band oscilloscopes. Bandwidth is dc to 1.7 GHz. This probe can also be used with 50 Ω sampling systems, with an appropriate BNC female adapter (017-0063-00).

The P6057 is equipped with a special BNC connector that provides trace identification and CRT READOUT information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

SPECIFICATIONS

Bandwidth — 1.4 GHz probe only. **Rise Time** — Less than 250 ps probe only. **Attenuation** — 100X. **Input Resistance** — 5000 Ω at dc; ≈ 1500 Ω at 1 GHz. **Input Capacitance** — 1.0 pF. **Maximum Input Voltage** — 50 V dc + peak ac to 500 MHz, decreasing to 21 V at 1 GHz. **Peak Pulse** — Not to exceed 500 V for 1 ms. **Temperature Range** — + 15 to + 55 °C. **Transit Time Variation** — Less than 70 ps probe to probe.

INCLUDED ACCESSORIES

344-0046-00	1 **CLIP,** alligator (AU)
206-0114-00	1 **TIP,** hook probe (CK)
013-0085-00	1 **TIP,** probe, bayonet (BM)
214-0283-00	1 **CONTACT,** electrical (CS)
175-0249-00	1 **LEAD,** ground, 3 in (7.5 cm) (AY)

ORDERING INFORMATION

P6057 100X, 50 Ω Probe, 6 ft, 010-6057-03 . . . . . $125

Opt 02, 9 ft, 010-6057-05 . . . . . $125

P6420 Rf Probe

The P6420 Rf probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the rms value of a sine wave input.

SPECIFICATIONS

Voltage Range — 0.5 V to 25 V rms (70.7 V p-p). **Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V rms ± 10% (15 °C to 35 °C). 5.0 V to 25 V rms ± 5% (15 °C to 35 °C). **Frequency Response** — 100 kHz to 300 MHz (± 0.5 dB). 50 kHz to 500 MHz (± 1.5 dB), 10 kHz to 1 GHz (± 3.0 dB). **Input Capacitance** — ≈ 3.7 pF. **Maximum Input Voltage** — 42.4 V (peak ac + dc). **Temperature Range** — Nonoperating; − 55 °C to + 75 °C. Operating; + 15 ° to + 35 °C. **Length** — Probe only 9.6 cm. Cable only 2 meters.

INCLUDED ACCESSORIES

013-0097-01	1 **TIP,** probe, retractable (BO)
344-0046-00	2 **CLIP,** alligator (AU)
175-0849-00	1 **LEAD,** ground, 3 in (7.5 cm) (BC)
175-1017-00	1 **LEAD,** ground, 6 in (13 cm) (BE)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
352-0351-00	1 **HOLDER,** probe
103-0090-00	1 **ADAPTER,** BNC female to dual banana (BN)
— — — —	2 **TIP,** probe, replaceable*

*Available in package of 10 only, order 206-0230-03 (CR).

ORDERING INFORMATION

P6420 Rf Probe, 2 m Cable Included, 010-6420-03 . . . . . $110

For a 1 meter length cable, (does not change specifications) 175-1661-00) $23

For a 3 meter length cable, (does not change specifications) 175-1661-02 . . . . . $23

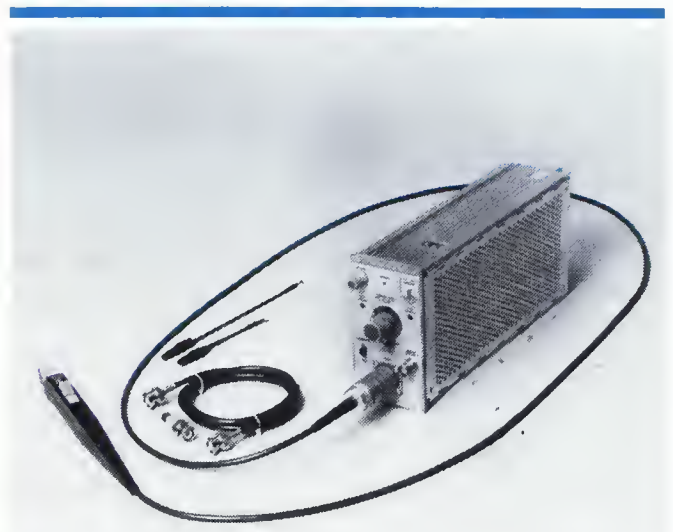
Included Accessories with double alpha codes are pictured on pages 284 and 285.

SUGGESTED MEASUREMENTS

- X-ray Tube Currents
- SCR Currents
- Power Supply Currents
- Motor Start-Up Currents
- Industrial Control Currents
- Relay Currents
- Common-Mode Rejection of Dc and Ac Currents

P6303 CURRENT PROBE

- 100 A Ac and Dc Current Measurements
- Dc to 15 MHz Bandwidth
- Peak Pulse Measurements to 500 A
- Ac or Dc Coupling
- 1 inch x 0.830 inch (2.5 x 2.1 cm) Jaw Opening
- Minimal Loading — 0.02 Ω Insertion Z at 1 MHz, 0.15 Ω at 15 MHz.



P6302 CURRENT PROBE

- 20 A Ac and Dc Current Measurements
- Dc to 50 MHz Bandwidth
- Peak Pulse Measurements to 50A, 50,000 A with the CT-5 Current Probe
- Current Probe
- Ac or Dc Coupling
- Small Loading — 0.1 Ω Insertion Z at MHz, 0.5 Ω at 50 MHz.

P6303/P6302

The TEKTRONIX P6303 and P6302 are two current probes designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope.

Both probes make ac or dc coupled current measurements simply by opening their sliding jaws and placing them around the conductor being tested. With their combination ac and dc measurement capabilities, both can measure fast transients, low frequency response, and dc levels all at the same time. For differential or sum measurements, just place the conductors in the probe jaw in the proper phase.

The P6303, measures currents to 100A within the frequency range of dc to 15 MHz. It features a large 1 x 0.83 inch (2.5 x 2.1 cm) jaw opening to accommodate large cables. Peak pulse measurements may be made to 500 A.

The P6302 measures currents to 20 A, 50 A peak, within the frequency range of dc to 50 MHz. By adding the CT-5 Current Probe, you can extend the capabilities of the P6302 to a 5000 A/div range (50,000 A peak).

Both the P6303 and the P6302 are used for making SCR power supply, industrial control, and motor start-up current measurements. The P6303 is especially recommended for measuring the current in X-ray tubes to insure compliance with the performance standards of PL 90-602, the Radiation Control for Health and Safety Act of 1968. Both are valuable measurement tools when low loading is important, as when testing high impedance points, or with current dependent devices.

The P6303 or P6302 is connected to the AM 503 through a multi-pin connector. The AM 503 operates in any of the TM 500 Power Modules. It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. Ac coupling allows the measurement of low amplitude signals on a high-level dc current. A front-panel light warns of input currents above 100 A dc with the P6303 or 20 A dc with the P6302. A push button allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the P6303/AM 503 can be displayed on any oscilloscope with at least a 50 MHz bandwidth and 10 mV sensitivity, the P6302/AM 503 on a 75 MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50 Ω recording instrument, or a 50 Ω termination which is supplied.

P6303 SPECIFICATIONS

Bandwidth — Dc to ≥ 15 MHz (– 3 dB), ≤ 7 Hz to ≥ 15 MHz (– 3 dB) ac coupled. Bandwidth can be limited to ≈ 5 MHz with AM 503 front-panel switch.

Rise Time — 23 ns or less.

Maximum Current — 100 A (dc + peak ac).

Maximum Peak Pulse Current — 500 A. Not to exceed 10,000 Aμs.

Sensitivity — 10 mA/div to 50 A/div within 3% (in calibrated steps) into 50 Ω load; indicating device (oscilloscope) sensitivity 10 mV/div.

Insertion Impedance — 0.02 Ω at 1 MHz, 0.15 Ω at 15 MHz.

Maximum Voltage (bare conductor) — 700 V.

Maximum Conductor Size — 0.830 inch (2.11 cm).

INCLUDED ACCESSORIES

016-0622-00 1 **CARRYING CASE**

P6302 SPECIFICATIONS

Bandwidth — Dc to ≥ 50 MHz (– 3 dB), ≤ 7 Hz to > 50 MHz (– 3 dB) ac coupled; the system's bandwidth may be limited to ≈ 5 MHz with the AM 503 front panel switch.

Rise Time — 7 ns or less.

Maximum Current — 20A (dc + peak ac).

Maximum Peak Pulse Current — 50 A. Not to exceed 100 Aμs.

Sensitivity — 1 mA/div to 5 A/div within 3% (in calibrated steps) into a 50 Ω load; indicating device sensitivity 10 mV/div.

Insertion Impedance — 0.1 Ω at 5 MHz, 0.5 Ω at 50 MHz.

Maximum Voltage (bare conductor) — 500 V.

Maximum Conductor Size — 0.15 inch.

Cable Length — 2 meters.

Propagation Delay — Approximately 30 ns.

INCLUDED STANDARD ACCESSORIES

175-0124-01 1 **LEAD,** elec, probe ground, 5 inch (13 cm) (AW)

175-0263-01 1 **LEAD,** elec, probe ground, 3 inch (7.5 cm) (AV)

344-0046-00 2 **CLIPS,** miniature alligator (AU)

ORDERING INFORMATION

P6303 Current Probe, 010-6303-01 ..... **$745**

P6302 Current Probe, 010-6302-01 ..... **$390**

AM 503 Current Probe Amplifier (See page 204) **$775**

F-5010P3 System (includes assembled and tested P6303, AM 503 and TM 501) **$1875**

F-5010P2 System (includes assembled and tested P6302, AM 503 and TM 501) **$1500**

AM 503 INCLUDED STANDARD ACCESSORIES

012-0057-01 1 **BNC CABLE,** 50 Ω (CV)

011-0049-01 1 **BNC TERMINATION,** 50 Ω (BJ)

The AM 503 Current Probe Amplifier requires one of the TM 500 Series Power Modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel of the power module. See page 218.

TM 501 Power Module **$270**
With Opt 02 Interface ..... Add $55

TM 503 Power Module **$270**
With Opt 02 Interface ..... Add $75

TM 504 Power Module **$300**
With Opt 02 Interface ..... Add $100

TM 506 Power Module **$420**
With Opt 02 Interface ..... Add $150

RTM 506 Power Module (rackmount version) **$530**
With Opt 02 Interface ..... Add $150

TM 515 Traveler Mainframe **$475**
With Opt 05 Interface ..... Add $75
With Opt 06 48-440 Hz Fan ..... Add $150

OPTIONAL ACCESSORIES

CT-5 Current Probe
Order 015-0189-01 ..... $880

CT-5 Opt 05 (w/o dc bucking coil)
Order 015-0189-00 ..... $715

Current Probes and Amplifier

Ac Current Probes—12 Hz to 2000 MHz

P6021 w/Term

For General Purpose Applications

120 Hz to 60 MHz

Clip-on Probe

The individual units, P6021, 134, and P6022 provide versatility in a user-assembled ac current measurement system. These various components can be assembled into a variety of performance packages.

P6021 w/134 — P6021 w/term

P6022 w/134 — P6022 w/term

The P6201 and P6022 are ac current probes designed for use with real time oscilloscopes. Either probe, with passive termination or with the amplifier, can be used with oscilloscopes having input resistance of 1 MΩ or greater. (Neither the termination nor the amplifier is required to use the P6021 Probe with the TEKTRONIX 5A21N Amplifier.) Both probes provide the facility for accurate current measurements over a wide range of frequencies

P6022 w/Term

Small Size Suitable for Compact Circuitry

935 Hz to 200 MHz

Clip-on Probe

without breaking the circuit under test. Just open the spring-loaded slide, place the conductor (up to 0.15 inch with P6021 and 0.1 inch with P6022) in the probe slot, and release the slide. No electrical connection is required.

The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under the test.

For general purpose applications, the P6021 offers wide-band performance with excellent low-frequency characteristics. The extra-small size of the P6022 makes it ideally suited for measuring current in compact semiconductor circuits.

Both probes' low-frequency capabilities and sensitivity can be expanded using the 134 Current Probe Amplifier.

PERFORMANCE CHARACTERISTICS

		Probe with Passive Termination	Probe with 134 Amplifier
Sensitivity	**P6021**	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ± 3%.	134 Amplifier switchable in steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ± 3%.
	P6022	1 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.	
Bandwidth†	**P6021**	2 mA/mV ≤ 450 Hz to 60 MHz 10 mA/mV ≤ 120 Hz to 60 MHz	12 Hz to 38 MHz
Probe Only*	**P6022**	1 mA/mV—≤ 8.5 kHz to 130 MHz 10 mA/mV—≤ 935 Hz to 200 MHz	100 Hz to 65 MHz
Max Current (CW)	**P6021**	15 A p-p sine wave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV.	15 A p-p sine wave between 230 Hz and 5 MHz
	P6022	6 A p-p sine wave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV.	6 A p-p sine wave between 1.3 kHz and 10 MHz
Max Current (Pulse)	**P6021**	250 A peak, not to exceed 500 A-μs or 5 A rms	15 A peak, not to exceed 500 A-μs or 5 A rms
	P6022	100 A peak, not to exceed 9 A-μs or 2 A rms	15 A peak, not to exceed 9 A-μs or 2 A rms
Noise			≤ 150 μA
Max Voltage (bare conductor)		600 V (dc + peak ac)	600 V (dc + peak ac)
Net Weight		≃ 1 lb	≃ 5 lb

†All bandwidths stated are −3dB

**To estimate the scope/probe system bandwidth from the probe only bandwidth, use the relationship*

$$(t_r \text{ system})^2 = (t_r \text{ probe})^2 + (t_r \text{ scope})^2$$

$$t_r \times BW = 0.35$$

134 Current Probe Amplifier

Use to Expand the Low Frequency Capability and Sensitivity of Either Probe

The 134 is used to extend the measurement capabilities of the P6021 or P6022 Current Probe. A CURRENT/DIV switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 and a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the CURRENT/DIV switch in the VOLTS position.

INCLUDED ACCESSORIES (P6021 and P6022)

175-0125-01 1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01 1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00 2 **CLIP,** alligator (AU)

ORDERING INFORMATION

P6021

P6021 Current Probe and Term, 5 ft, 015-0140-02 ..... $260

Opt 02, 9 ft and Term, 015-0140-03 ..... Add $265
Opt 06, 5 ft w/o Term, 010-0237-02 ..... Add $225
Opt 02 and 06, 9 ft w/o Term, 010-0244-02 ..... Add $225

P6022

P6022 Current Probe and Term, 5 ft. 015-0135-00 ..... $290

Opt 02, 9 ft and Term, 015-0135-01 ..... Add $290
Opt 06, 5 ft w/o Term, 010-0238-00 ..... Add $230
Opt 02 and 06, 9 ft w/o Term, 010-0238-02 ..... Add $230

134

134 Current Probe Amplifier, 015-0057-02 ..... $485

Included Accessories:
014-0029-00 1 **HANGER** assembly
012-0104-00 1 **CABLE** assembly (CX)
015-0058-01 1 **POWER SUPPLY,** 110 V

Opt 04, 230 V ac, 015-0057-03 ..... Add $485
Included Accessories: Same as above, but with 230 V power supply (015-0059-01).

OPTIONAL ACCESSORIES for P6021, P6022, and 134

Calibrator Adapter, BNC, Order 013-0092-00 ..... $33
Carrying Case for P6021 or P6022, and a 134 Amplifier, Order 016-0087-01 ..... $20

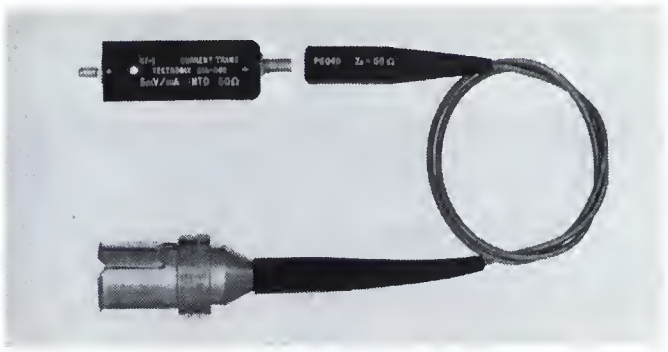
Passive Termination

For P6021, Order 011-0105-00 ..... $95
For P6022, Order 011-0106-00 ..... $105

Included Accessories with double alpha codes are pictured on pages 284 and 285.

CT-1

1 GHz Ac Current Probe for 50 Ω Systems



Used with 50 Ω Systems, or Wide Band Non-sampling Oscilloscopes Using a 50 Ω Term

CT-1 Permanently Inserted in 50 Ω Circuit Has Minimum Effect on the 50 Ω Environment

Probe Cable

The 010-0133-00 probe cable is an interconnecting cable for the CT-1, used between the transformer and oscilloscope input. If several CT-1 Transformers are in a circuit, the probe cable can be used to monitor any one of them.

The probe cable can be used with other test-point connectors, such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF.

SPECIFICATIONS

Sensitivity — 5 mV/mA within ± 3% into a 50 Ω load. **Decay Time Constant** — 6.35 μs, approximated by 1% per 50 ns; limit, 1 μs. **Rise Time** — less than 350 ps. **Frequency Response** — 25 kHz to 1 GHz (−3 dB). **Insertion Impedance** — 1 Ω shunted by ≈ 6μH with a 50 Ω termination; 2 Ω shunted by ≈5 μH without a 50 Ω termination. **Capacitance Loading** — Typically 1.5 pF for bare #14 gauge wire passing through the CT-1 transformer; 0.6 pF for #20 gauge. **Maximum Voltage of Circuit Under Test** — 1000 V (dc plus peak ac). **Direct Current** — Reduces the L/R time constant by a factor of 2 at 75 mA. **Pulse Current Rating** — 12 A peak, with a 50 Ω load, with a maximum amp-second product of 1 A μs. **Rms Current Rating** — 450 mA maximum with a 50 Ω load. **Temperature Rating** — 25°C to ± 65°C. **Transformer Physical Dimensions** — 3/8 x 9/16 x 1-13/16 in; #6-32 x 1/4 inch mounting stud. **Probe Cable Impedance** — 50 Ω. **Probe Cable Attenuation** — 1X. **Cable Length** — 18 in. **Output Connector** — GR type.

ORDERING INFORMATION

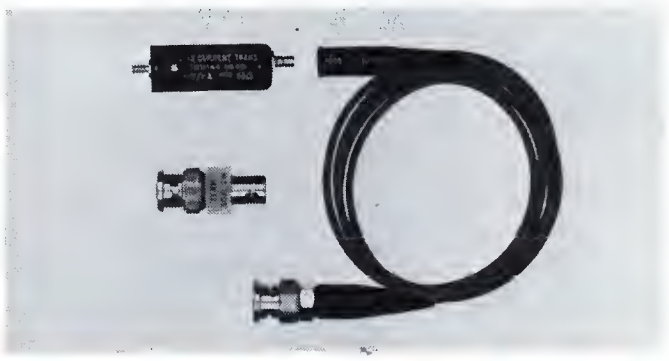
CT-1 Current Transformer and Probe, 015-0041-00 ..... $115

Opt 05 CT-1 Current Transformer (without Probe), 015-0040-00 ..... $70

Probe Cable, 010-0133-00 ..... $55

CT-2

100 MHz Ac Current Probe



Use with Oscilloscopes up to 100 MHz BW

Insulated Case for Limited Space Applications

Several CT-2 Transformers Can Be Used in the Circuit and Monitored by One Cable

Probe Cable

The 010-0164-00 probe cable connects the CT-2 Transformer and the oscilloscope input. A 50 Ω termination is used with the probe cable for terminating the probe cable at the high impedance input of the oscilloscope.

SPECIFICATIONS

Sensitivity — 1 mV/mA within 3% into a 50 Ω load. **Decay Time Constant** — 160 μs, approximated by 1% per 1.25 μs; limit, 25 μs. **Rise Time** — 0.5 ns. **Frequency Response** — up to 100 MHz; −3dB at 1.2 kHz, −3dB at 200 MHz. **Insertion Impedance** — 0.04 Ω shunted by ≈7 μH in series with 0.9 μH with a 50 Ω termination; 0.08 Ω shunted by ≈7μH in series with 0.9 μH without a 50 Ω termination. **Capacitance Loading** — Typically 1.8 pF for a bare #16 gauge wire passing through the CT-2 transformer; 0.7 pF for a #22 gauge wire. **Maximum Voltage of Circuit Under Test** — 1000 V (dc + peak ac). **Direct Current** — Reduces the L/R time constant by a factor of 2 at 175 mA. **Pulse Current Rating** — 36 A peak, with a maximum amp-second product of 50 A μs. **Rms Current Rating** — 1.25 A maximum. **Temperature Rating** — 25°C to +65°C. **Transformer Physical Dimensions** — Same as CT-1. **Probe Cable Impedance** — 50 Ω. **Probe Cable Attenuation** — 1X. **Cable Length** — 42 inches. **Output Connector** — BNC type.

Included Accessories:

010-0164-00	1 **CABLE,** probe
011-0049-01	1 **TERMINATION,** 50 Ω (BJ)

ORDERING INFORMATION

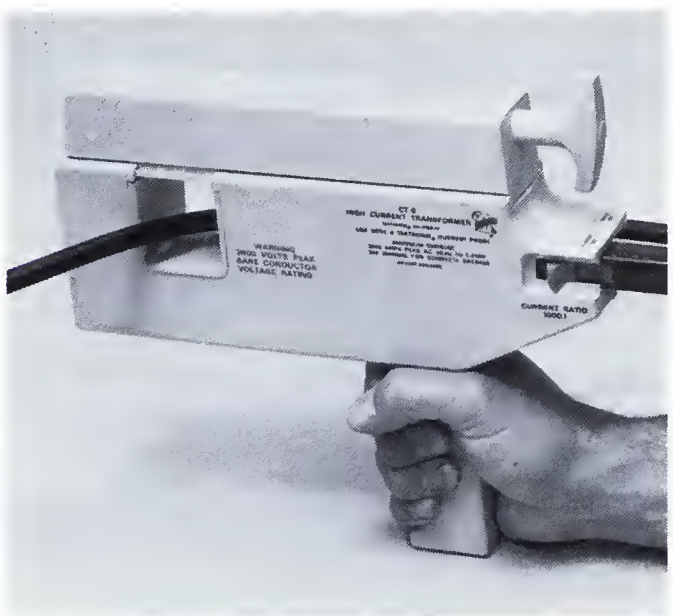
CT-2 Plus Cable and Term, 015-0047-00 ..... $120

Opt 05 w/o Cable or Term, 015-0046-00 ..... $75

Probe Cable, (010-0164-00) $42

CT-5

Pulsed Currents to 50,000 A



20 mA per Division Sensitivity

1.5 Inch Diameter Conductors

Measurements on Bare Conductors to 3000 V Nullifies Dc Effects to 300 A

The CT-5 is a clip-on high-current transformer which extends the measurement capability of Tektronix Clip-on Current Probes. Maximum low-frequency performance is obtained using the P6302/AM 503 Dc Current Probe. Pulse current to 50,000 A may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 Current Probe Amplifier may also be used for measurements at normal power line frequency and above. (The P6022 and CT-5 are not compatible with each other.) The CT-5 has receptacles for current probes in either 20:1 or 1000:1 step-down ratios. The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. The core and shield assembly is insulated from the windings and the handle. This allows measurements on bare conductors to 3000 V, and to 10 kV rms when using high voltage bushing.

Use of dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading the measurements. This is very useful for measuring ac signals riding on top of dc.

CT-5 CHARACTERISTICS

The following are characteristics of the CT-5 using either the P6302/AM 503 or P6021/134 combinations.

Rise Time is 17.5 ns or less. **Insertion Impedance** is 20 μΩ or less at 60 Hz, increasing to 20 mΩ at 1 MHz. **Current Range** is 20 mA/div to 100 A/div with P6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with P6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio). **Accuracy** is ±4%. Max Current is 1000 A peak cw.* **Amp-Sec product** is 8 A-s. **Max Voltage** of circuit test is 3000 V (bare conductor). **Max Dc Bucking Current** is 300 mA to buck out 300 A dc (using dc bucking coil). **Dimensions and weight** — the length is 10.5 in, width is 2.25 in, height is 9.5 in, net weight is approx 4 lb.

**Max current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.*

Included Accessories:

016-0191-03	1 **CARRYING CASE**
015-0194-00	1 **BUSHING,** high voltage, 12 in

ORDERING INFORMATION

CT-5 Current Probe (includes Dc Bucking Coil) 015-0189-01 ..... $880

Opt 05 w/o Dc Bucking Coil, 015-0189-00 ..... $715

OPTIONAL ACCESSORIES

Dc Bucking Coil, 015-0190-00 ..... $210

High-Voltage Bushing, 4 ft long, inside diameter 1 in, 015-0194-01 ..... $35

CT-3 SIGNAL PICKOFF

Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

Sensitivity is 10% of the voltage under test, into a 50 Ω load. **Decay Time Constant** is 4.5 μS at 0 dc current. **Rise Time** is less than 0.4 ns. **Frequency Response** is 50 kHz to 875 MHz at 0 dc current. **Insertion Impedance** with a 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 M termination. **Vswr** is less than 1.2 at 1.5 GHz. **Voltage Rating** at 0 V dc is 25 V rms, 1 kV pulse peak. The Vs product is 100 Vμs. If exceeded, the L/R decay will decay rapidly toward zero.

CT-3 Signal Pickoff, Order 017-0061-00 ..... $125

CT-5 Current Measurement Combinations

Product	Current Div Scope Set		Bandwidth	A-s Product	Max Current	
	10 mV/div	50 mV/div			RMS	Peak Pulse
CT-5/P6302/AM 503	20 mA to 5 kA		0.5 Hz to 20 MHz	0.1	700 A	50 kA
CT-5/P6021/134		20 mA to 1 kA	12 Hz to 20 MHz	0.5	700 A	15 kA
CT-5/P6021/Term	400 mA to 100 A	2A to 500 A	120 Hz to 20 MHz	0.5	700 A	50 kA

Modular Passive Probes

P6101 Dc to 34 MHz 1X

P6105 Dc to 100 MHz 10X

P6106 Dc to 300 MHz 10X

Simplified, Faster Maintenance and Repairs

High Fidelity Signal Acquisition at Low Cost

Rugged for Greater Reliability

Available in Three Lengths

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6107, P6108, and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap together making maintenance and repair less expensive, faster, and much easier. Snap-on replacement modules eliminate soldering irons and tools, and modular probes do not have to be sent in to be repaired because spare modules can be ordered and stocked. Strain relief and modular component design make these probes rugged for greater reliability.

The P6101, P6105, P6106, and P6108 are available in three color-coded lengths — blue for one meter, yellow for two meters, and red for three meters. (The P6149 and P6107 are two meters long.) These probes may be used to acquire high fidelity signals from low source-impedance circuits.

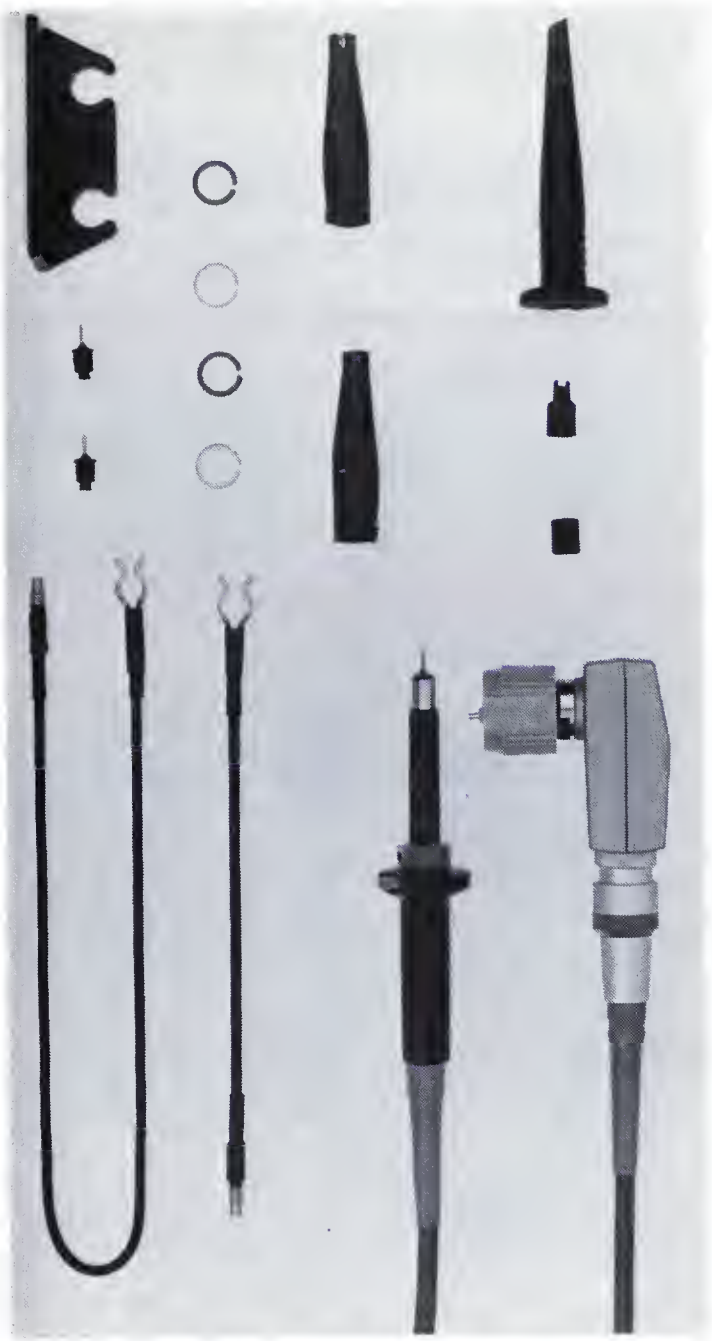
Tektronix Modular Probes are designed for specific Tektronix Instruments, but may be purchased as options for all Tektronix Oscilloscopes with 1 MΩ and appropriate pF inputs as indicated in the chart. The P6106 is standard with the 475A and 475 oscilloscopes.

The P6105 is standard with the TEKTRONIX 434, 455, 465B, and rackmount oscilloscopes. And the P6108 is standard with the T932A and T935A oscilloscopes.

Modular parts snap together

For modular probe replacement parts, see page 284.

P6107 Dc to 100 MHz 10X



P6108 Dc to 100 MHz 10X

P6149 Dc to 50 MHz 10X

The P6101 is a 1X, 1 MΩ probe. The P6105, P6106, P6107, and P6108 are 10X, 10 MΩ probes.

With oscilloscopes that are equipped with vertical scale or CRT readout, the P6105 and P6106 will automatically scale the readout by a factor of 10. This makes mental calculations unnecessary. Also ground level can be determined on the display by actuating a button on the probe head, without having to return to the oscilloscope.

The P6149 features a right angle BNC connector. This can be useful when bench space is limited.

INCLUDED ACCESSORIES

All probes, except as noted

013-0107-03	1 **TIP,** retractable hook (BS)
166-0404-01	1 **SLEEVE,** insulating (CH)
175-0124-01	1 **LEAD,** ground, 13 cm (AW)
175-0125-01	1 **LEAD,** ground, 30 cm (AX) P6101, P6105, P6108, P6149 only
175-0263-01	1 **LEAD,** ground, 7.5 cm P6106 only (AV)
————**	2 **TIPS,** probe
————*	3 **PR. MARKER BANDS,** (black, white, and silver gray) All except P6149 (not shown)
————*	2 **PR. MARKER BANDS,** (gray, and silver gray) P6149 (not shown)
344-0046-00	2 **CLIPS,** miniature, alligator (AU)
352-0351-00	1 **PROBE HOLDER**
016-0521-00	1 **POUCH,** accessory (not shown)

**Available in packages of 10 only, 206-0191-01. (CM)

*Available in packages of 9 sets of different colors—016-0633-00.

SPECIFICATIONS

Type	Attenuation	Length	Package Number	Loading		Useful BW MHz	Dc Max	Scope in pF	Readout
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	1 MΩ	32 pF 54 pF 78 pF	34 15.5 8	500 V[1]	ANY	—
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V[3]	15 to 47	YES
P6106	10X	1 m 2 m 3 m	010-6106-01 010-6106-03 010-6106-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	300[5] 250 150	500 V[4]	15 to 24	YES
P6107	10X	2 m	010-6107-03	10 MΩ	13.0 pF	100	500 V[3]	14 to 47	YES
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V[3]	15 to 47	NO
P6149	10X	2 m	016-6149-03	10 MΩ	15.5 pF	50	500 V[3]	20 to 62	NO

[1]Max Input Voltage is 500 V dc + peak ac to 300 kHz derated to 20 V at 30 MHz.
[2]Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 27 V at 100 MHz.
[3]Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 30 V at 50 MHz.
[4]Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 70 V at 100 MHz.
[5]Scope bandwidth must be 325 MHz.

ORDERING INFORMATION

P6101, 1X Probe, 2 m, 010-6101-03 ..... $53
Opt 01, 1 m, 010-6101-01 ..... $53
Opt. 02, 3 m, 010-6101-05 ..... $53

P6105, 10X Probe, 2 m, 010-6105-03 ..... $90
Opt 01, 1 m, 010-6105-01 ..... $90
Opt 02, 3 m, 010-6105-05 ..... $90

P6106, 10X Probe, 2 m, 010-6106-03 ..... $110
Opt 01, 1 m, 010-6106-01 ..... $110
Opt 02, 3 m, 010-6106-05 ..... $110

P6107, 10X Probe, 2 m, 010-6107-03 ..... $95

P6108, 10X Probe, 2 m, 010-6108-03 ..... $80
Opt 01, 1 m, 010-6108-01 ..... $80
Opt 02, 3 m, 010-6108-05 ..... $80

P6149, 10X Probe, 2 m, 010-6149-03 ..... $85

Included Accessories with double alpha codes are pictured on pages 284 and 285.

Monolithic Passive Probes

P6006 and P6007 Probes

P6006 Dc to 35 MHz 10X

The P6006 is a general-purpose probe. It can be compensated to match all TEKTRONIX Plug-ins and Oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ. This probe is more rugged and has a higher voltage rating than the miniature probes.

SPECIFICATIONS

Attenuation — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 7.5 pF for 3.5 ft probe cable when used with an instrument having 20 pF input capacitance; 8.5 pF for 6 ft version; 11 pF for 9 ft version; 13 pF for 12 ft version. **Bandwidth** — Dc to 35 MHz for 3.5 ft version. **Voltage Rating** — 600 V dc, ac peak or dc and ac peak combined. Peak-to-peak voltage derating is necessary for cw frequencies higher than 5.7 MHz when working into a 20 pF input, or higher than 3.6 MHz when working into a 47 pF input.

INCLUDED ACCESSORIES

013-0071-00	1 **TIP,** probe, retractable hook (AD)
134-0013-00	1 **PLUG,** tip, banana (AF)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
206-0015-00	1 **TIP,** probe (0.055 in dia) (AH)
206-0060-00	1 **TIP,** probe (0.080 in dia) (AI)
206-0105-00	1 **TIP,** probe, hook (AM)
344-0046-00	2 **CLIP,** alligator (AU)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6006 10X Probe, 6 ft, 010-0160-00 . . . . . $72

Opt 01, 3.5 ft BNC, 010-0127-00 . . . . . $72
Opt 02, 9 ft BNC, 010-0146-00 . . . . . $72
Opt 03, 12 ft BNC, 010-0148-00 . . . . . $72

P6007 Dc to 25 MHz 100X

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all TEKTRONIX Plug-ins and Oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ. The P6007 is similar to the photo of the P6006.

SPECIFICATIONS

Attenuation — 100X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 2.0 pF for 3.5 ft probe cable when used with an instrument having 20 pF input capacitance; 2.2 pF for the 6 ft version; 2.4 pF for the 9 ft version; 2.6 pF for the 12 ft version. **Bandwidth** — Dc to 25 MHz. **Voltage Rating** — 1.5 kV dc or ac rms, 4.2 kV ac peak-to-peak. P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 10 MHz, the maximum allowable p-p voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the instrument used.

INCLUDED ACCESSORIES

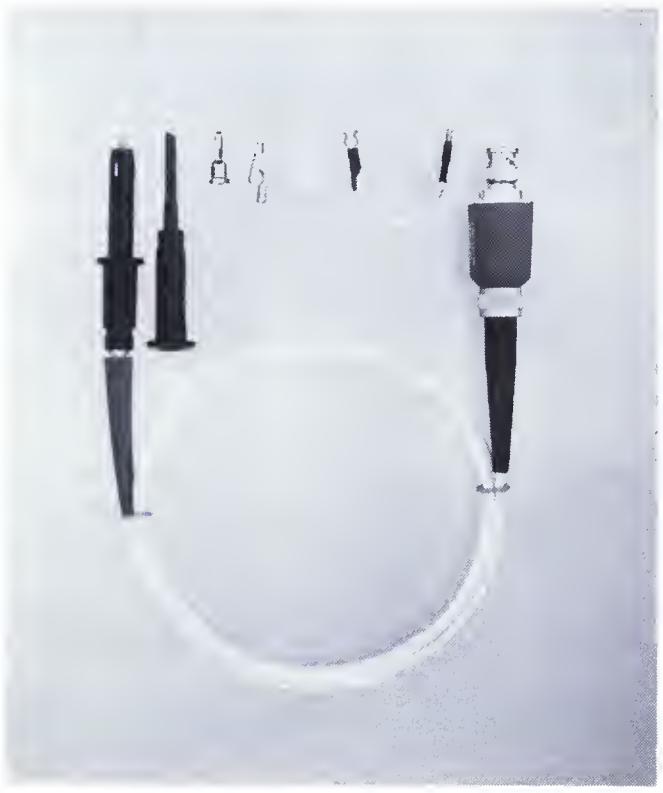
Same as for P6006.

ORDERING INFORMATION

P6007 100X Probe, 6 ft, 010-0165-00 . . . . . $85

Opt 01, 3.5 ft, 010-0150-00 . . . . . $85
Opt 02, 9 ft, 010-0152-00 . . . . . $85
Opt 03, 12 ft, 010-0154-00 . . . . . $85

P6008 Probes



P6008 (Environmental) 10X

The P6008 Environmental Probe is designed to operate over −50 °C to +150 °C for the probe body and cable; the compensation box operates from −15 ° to +55 °C. It is designed for use with Tektronix dc to 100 MHz Oscilloscopes. The probe can be compensated to match Tektronix Plug-ins and Oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance to 1 MΩ.

SPECIFICATIONS

Attenuation — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — ≈ 7.5 pF when used with an instrument having a 20 pF input capacitance. **Bandwidth** — Dc to 100 MHz. **Voltage Rating** — 600 V dc, ac peak, or dc and ac peak combined. Peak-to-peak voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

INCLUDED ACCESSORIES

134-0013-00	1 **PLUG,** tip, banana (AF)
344-0045-00	1 **CLIP,** alligator (AT)
175-0925-00	1 **LEAD,** ground, 12 in (30 cm) (BD)
352-0090-00	1 **HOLDER,** probe
013-0071-01	1 **TIP,** probe, retractable hook (AE)

ORDERING INFORMATION

P6008 Environmental 10X Probe, 6 ft, 010-0129-01 . . . . . $175

P6008 (Non-Environmental) 10X

The P6008 Non-Environmental Probe is designed for use with Tektronix dc to 100 MHz Oscilloscopes. This 10X attenuation probe can be compensated to match plug-ins and oscilloscopes with input capacitances of 8 pF to 50 pF and input resistance of 1 MΩ.

The P6008 (Non-Environmental) is similar to the photo of the P6008 (Environmental).

SPECIFICATIONS

Attenuation — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — ≈ 7.5 pF when used with an instrument having a 20 pF input capacitance. **Bandwidth** — Dc to 100 MHz. **Voltage Rating** — 600 V dc, ac peak, or dc and ac peak combined. Peak-to-peak voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

INCLUDED ACCESSORIES

134-0013-00	1 **PLUG,** tip, banana (AF)
344-0046-00	1 **CLIP,** alligator (AU)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
352-0068-00	1 **HOLDER,** probe
013-0071-00	1 **TIP,** probe, retractable hook (AD)
206-0060-00	1 **TIP,** probe (0.080 in dia) (AI)
206-0105-00	1 **TIP,** probe, hook (AM)
206-0015-00	1 **TIP,** probe (0.055 in dia) (AH)
013-0052-00	1 **TIP,** probe, retractable hook (AA)

ORDERING INFORMATION

P6008 Non-Environmental 10X Probe, 3.5 ft, 010-0129-00 . . . . . $160

P6009 Dc to 120 MHz 100X

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with Tektronix dc to 150 MHz Oscilloscopes. The probe can be compensated to match Tektronix Plug-ins and Oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides CRT READOUT information when used with plug-in units and mainframes that have these features. The readout connector is not compatible with most standard non-readout BNC connectors.

SPECIFICATIONS

Attenuation — 100X. **Input Resistance** — 10 MΩ. **Input Capacitance** — ≈ 2.5 pF when used with instrument having 20 pF input capacitance. **Bandwidth** — Dc to 120 MHz. **Voltage Rating** — 1.5 kV dc or ac rms, 4 kV ac peak-to-peak. P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 40 MHz, the maximum allowable p-p voltage is 425 V.

INCLUDED ACCESSORIES

175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
013-0071-00	1 **TIP,** probe, retractable hook (AD)
013-0052-00	1 **TIP,** probe, retractable hook (AA)
344-0046-00	2 **CLIP,** alligator (AU)
206-0060-00	1 **TIP,** probe, (0.080 in dia) (AI)
206-0105-00	1 **TIP,** probe, hook (AM)
134-0013-00	1 **PLUG,** tip, banana (AF)
206-0015-00	1 **TIP,** probe (0.055 in dia) (AH)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6009 100X Probe, 9 ft, w/Readout, 010-0264-01 . . . . . $135

Opt 04 w/o Readout, 010-0170-00 . . . . . $135

P6015 40 kV 1000X

High Voltage Probe

- Measure Up to 40 kV Peak Pulse
- Up to 20 kV Dc + Peak Ac
- 1000X Attenuation
- 75 MHz Useful Bandwidth
- For 1 MΩ Inputs

The P6015 provides 1000X attenuation for oscilloscope measurements up to 40 kV peak. Voltage or duty cycle derating is necessary for rf voltages at frequencies over 100 kHz, or in temperatures above 25 °C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF.

SPECIFICATIONS

Voltage Rating—40 kV, peak pulse; 20 kV dc or rms continuous at 25 °C. Peak-to-peak voltage derating is necessary for cw frequencies higher than 100 kHz or in temperatures above 25 °C. At 10 MHz the maximum allowable p-p voltage is 13 kV. **Attenuation**—1000X. **Input Resistance**—100 MΩ. **Input Capacitance**—≈3 pF. **Probe Rise Time**—≈4 ns. **Temperature Range**—10 °C to 55 °C. **Cable Length** — 10 ft.

INCLUDED ACCESSORIES

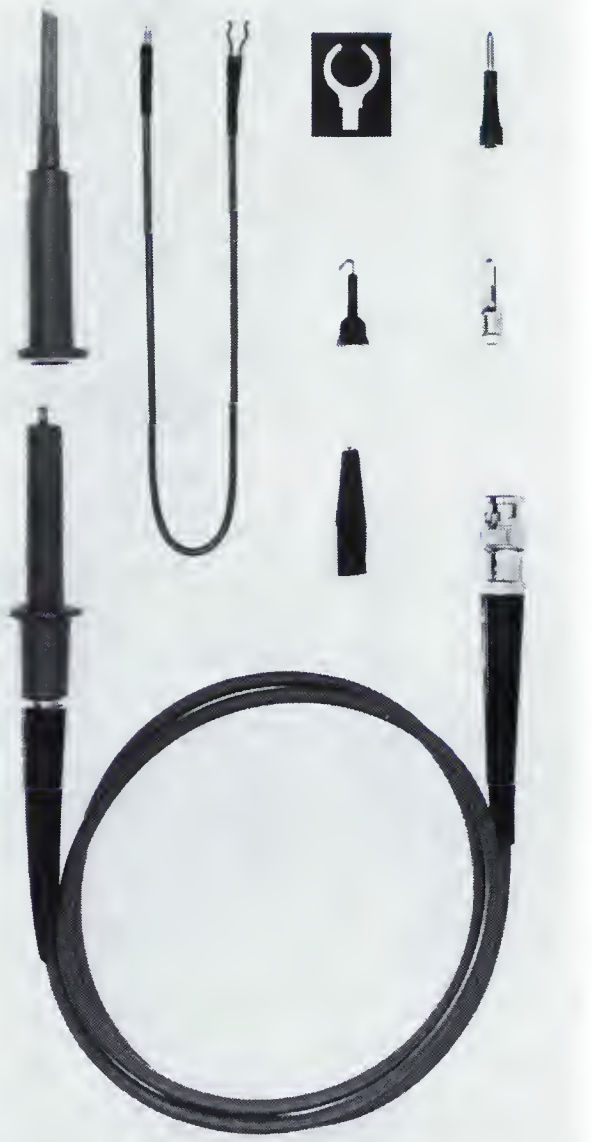
015-0049-00	1 **COMPENSATING BOX,** BNC
344-0005-00	1 **CLIP,** alligator (AS)
352-0056-00	1 **PROBE HOLDER**
252-0120-00	1 **CAN,** high-voltage dielectric fluid (BH)
016-0128-02	1 **CARRYING CASE**

ORDERING INFORMATION

P6015 1000X Probe, 10 ft cable, 010-0172-00 . . . . . $500

Included Accessories with double alpha codes are pictured on pages 284 and 285.

P6028 Dc to 17 MHz 1X



The P6028 is a general-purpose 1X voltage probe designed for use with Tektronix Oscilloscopes that have BNC input connectors.

SPECIFICATIONS

Attenuation — 1X. **Input Resistance** — 1 MΩ, instrument input R included. **Input Capacitance** — 30 pF for 3.5 ft probe cable; 47 pF for 6 ft version; 70 pF for 9 ft version; 92 pF for 12 ft version, instrument capacitance excluded. For total input capacitance of the system, add input C of instrument. **Probe Rise Time** — ≈10 ns. **Bandwidth** — Dc to 17 MHz. **Voltage Rating** — 600 V dc or ac peak-to-peak. P-p voltage derating is necessary for cw frequencies higher than 1 MHz. At 10 MHz, the maximum allowable p-p voltage is 60 V.

INCLUDED ACCESSORIES

175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
352-0068-00	1 **HOLDER,** probe, molded
344-0046-00	1 **CLIP,** alligator (AU)
013-0071-00	1 **TIP,** probe, retractable hook (AD)
134-0013-00	1 **PLUG,** tip, banana (AF)
206-0105-00	1 **TIP,** probe, hook (AM)
206-0060-00	1 **TIP,** probe, 0.080 in dia (AI)

ORDERING INFORMATION

P6028 1X Probe, 6 ft, 010-0075-00 . . . . . $43

Option 01, 3.5 ft, 010-0074-00 . . . . . Add $43
Option 02, 9 ft, 010-0076-00 . . . . . Add $43
Option 03, 12 ft, 010-0077-00 . . . . . Add $43

Monolithic Passive Probes

P6048 Dc to 200 MHz 10X

Low capacitance 1 pF · 1kΩ

AC/DC Switch

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF Oscilloscopes. The probe input impedience of 1 k Ω paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. Ac or dc coupling switch is available to extend the measurement range.

SPECIFICATIONS

Attenuation—10X. **Input Resistance**—1K Ω. **Input Capacitance**—1 pF or less. **Maximum Input dc**—20V; Ac-200 V. **Ac Low Frequency**—7 kHz or less. **Bandwidth**—(with 250 MHz oscilloscope with 1 MΩ/20 pF input) 175 MHz. **Typical Probe Risetime**—1.95 ns.

INCLUDED ACCESSORIES

013-0085-00	1 **TIP,** probe, bayonet (BM)
013-0090-00	1 **TIP,** probe, rectractable hook (BN)
166-0404-01	2 **INSULATING SLEEVE,** electrical (CH)
166-0433-00	1 **INSULATING SLEEVE,** ground lead (CI)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
206-0114-00	1 **TIP,** hook probe (CK)
344-0046-00	2 **CLIP,** alligator (AU)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6048 10X Probe, 6 ft,
010-0215-00 . . . . . $155

P6053B Dc to 250 MHz 10X

The P6053B is a miniature fast-rise 10X probe designed for Tektronix Instruments having a nominal input capacitance of 15 to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

SPECIFICATIONS

Attenuation — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 9.5 pF with 3.5 ft probe, 12.5 pF with 6 ft version, 13.5 pF with 9 ft version. **Bandwidth** (with 225 MHz or greater oscilloscope — ≈200 MHz for 3.5 and 6 ft versions, ≈115 MHz for the 9 ft version. **Voltage Rating** — 500 V (dc + peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the max allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.

INCLUDED ACCESSORIES

013-0107-03	1 **TIP,** probe, retractable (BS)
352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** hook probe, (CK)
013-0085-00	1 **TIP,** probe, bayonet (BM)

Trace Identify Function for Scopes with CRT Readout

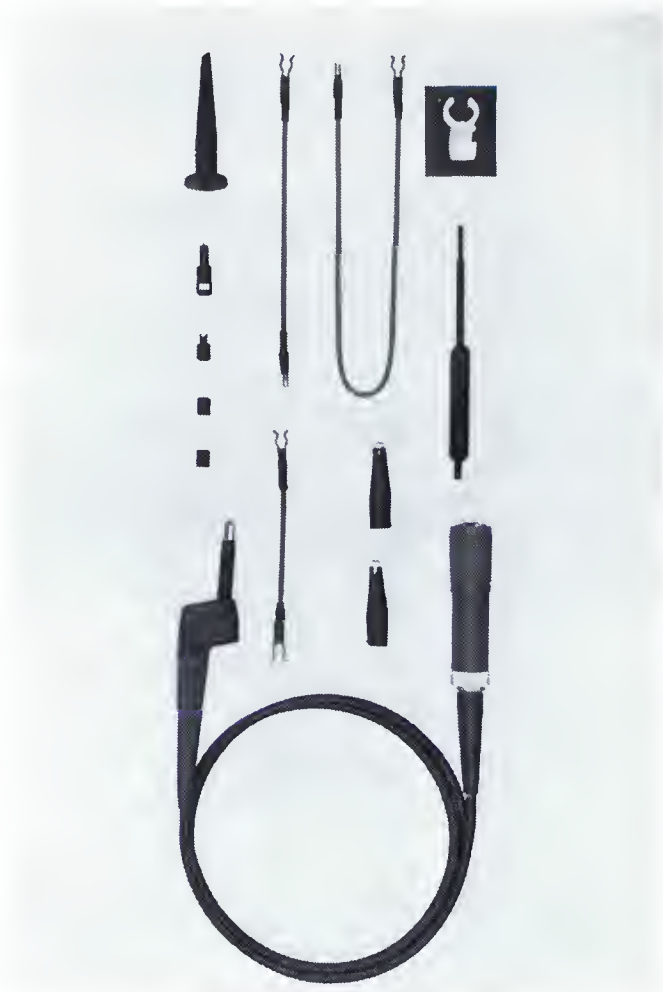
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00	2 **CLIP,** alligator (AU)
166-0404-01	2 **INSULATING SLEEVE,** electrical (CH)

ORDERING INFORMATION

P6053B 10X Probe, 6 ft,
010-6053-13 . . . . . $120
Opt 01, 3.5 ft, 010-6053-11 . . . . . Add $120
Opt 02, 9 ft, 010-6053-15 . . . . . Add $120

Included Accessories with double alpha codes are pictured on pages 284 and 285.

P6055 20,000:1 Cmrr 10X



The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix Differential Amplifiers having nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the cmrr of the system.

SPECIFICATIONS

CMRR — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz. **Attenuation** — Adjustable to 10X. **Input Resistance** — 1 MΩ ±0.5%. **Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance. **Maximum Useful Bandwidth** — 60 MHz. **Typical Probe Rise Time** — 5.8 ns. **Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. Peak-to-peak voltage derates to 100 V at 70 MHz.

INCLUDED ACCESSORIES

013-0107-03	1 **TIP,** probe, retractable (BS)
003-0675-01	1 **ADJUSTABLE TOOL,** probe (CU)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-1256-00	1 **LEAD,** electrical, 6 in (13 cm) (BG)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
206-0114-00	1 **TIP,** hook probe, (CK)
344-0046-00	2 **CLIP,** alligators (AU)
166-0404-01	2 **INSULATING SLEEVE,** electrical (CH)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6055 10X Differential Probe, 3.5 ft,
010-6055-01 . . . . . $200

P6060 Dc to 35 MHz 10X

The P6060 is a precision passive probe with 10X attenuation, for use with Tektronix low and mid-frequency oscilloscopes used in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications, such as amplitude measurements with a differential comparator. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 MΩ.

The BNC-type connector utilizes a special grounding clip to shift the deflection factor indicator to 10X normal reading in 5000-Series Oscilloscopes.

SPECIFICATIONS

Attenuation — 10X. Accuracy when used with a 1 MΩ ±0.15% instrument input will be within ±0.4% When used with a 1 MΩ ±2% instrument input the accuracy will be within ±2%. **Input Resistance** — 10 MΩ within ±0.25% within a 1 MΩ ±0.15% instrument input; 10 MΩ within ±0.4% when used with a 1 MΩ ±2% instrument input. **Input Capacitance** — ≃ 6.0 pF for 3 5 ft probe cable when used with instrument having 15 pF input capacitance; ≃ 7.7 pF with 6 ft version; ≃ 9.5 pF with 3.5 ft version when used with 55 pF instruments; ≃ 11.5 pF for 6 ft version. **Cmrr (Probe Pair)** — At least 400:1 (with 5A20N or 5A21N) dc to 30 kHz. **Bandwidth** — at least 35 MHz with 3.5 ft probe (with scope bandwidth of at least 60 MHz); 25 MHz with 6 ft probe. **Maximum Input Voltage** — 600 V dc plus peak ac. Peak-to-peak derating is necessary for cw frequencies higher than 3 MHz. Maximum input voltage at 50 MHz is 50 V.

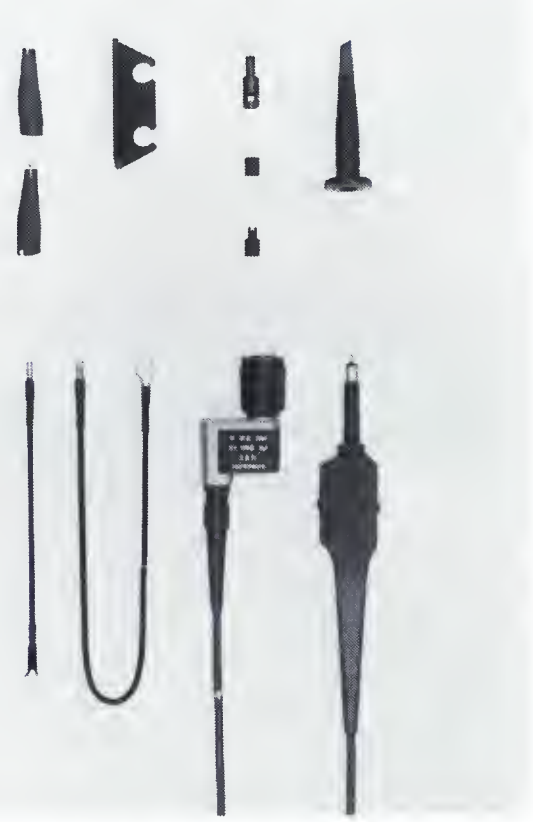
INCLUDED ACCESSORIES

206-0060-00	1 **TIP,** probe (0.080 (AI)
344-0046-00	2 **CLIP,** alligator (AU)
134-0013-00	1 **PLUG,** tip, banana (AF)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
206-0105-00	1 **TIP,** probe, hook (AM)
206-0015-00	1 **TIP,** probe, (0.055 in dia) (AH)
013-0071-00	1 **TIP,** probe, retractable hook (AD)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6060 10X Probe, 6 ft,
Order 010-6060-03 . . . . . $70
Opt 01, 3.5 ft, Order 010-6060-01 . . . . . $70

P6062B Dc to 100 MHz
1X, 10X Selectable Attenuation



The P6062B is a passive dual attenuation probe designed for Tektronix Oscilloscopes with bandwidths to 100 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multitrace display. The P6062B can be compensated with instruments having a nominal input capacitance of 15 to 47 pF. The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

SPECIFICATIONS

Attenuation — 10X and 1X. **Input Resistance** — 1X position, 1 MΩ; 10X position, 10 MΩ ±0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input Capacitance** — 3.5 ft probe cable is 100 pF in the 1X position, 13.5 pF in the 10X position; 6 ft version is 105 pF in the 1X position, and 14 pF in the 10X position. 9 ft probe cable is 135 pF in the 1X position and 17 pF in the 10X position. **Bandwidth** — 10X probe is at least 100 MHz for the 3.5 ft and 6 ft version; 95 MHz for the 9 ft version when used with a 100 MHz Oscilloscope. 1X probe is at least 8 MHz for the 3.5 ft version, at least 6 MHz for the 6 ft version and at least 4.5 MHz for the 9 ft version. **Voltage Rating** (10X Position) — 500 V (dc + peak ac derated with frequency and oscilloscope input coupling). 1X position, 100 V (dc + peak ac derated with frequency).

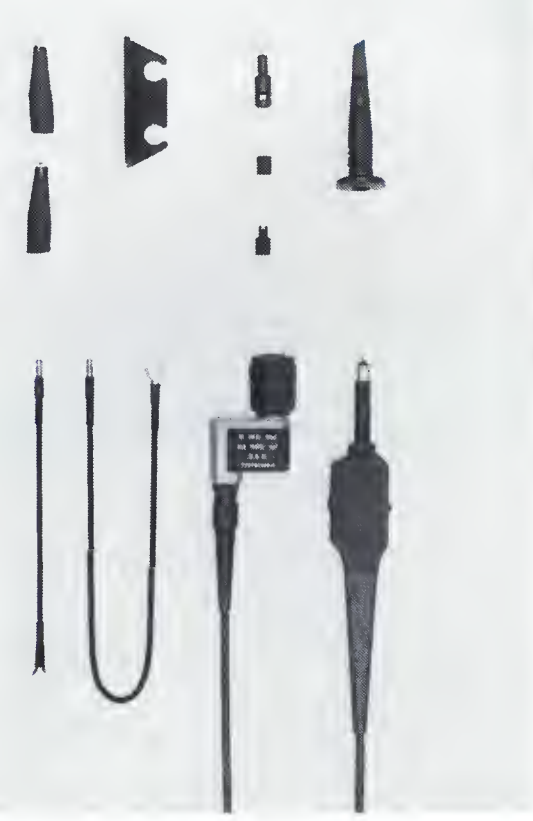
INCLUDED ACCESSORIES

352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** hook probe (CK)
013-0107-03	1 **TIP,** probe, retractable (BS)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
344-0046-00	2 **CLIP,** alligator (AU)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
016-0521-00	1 **POUCH,** accessory

ORDERING INFORMATION

P6062B Switchable Attenuation Probe, 6 ft,
Order 010-6062-13 . . . . . $136
Opt 01, 3.5 ft, Order 010-6062-11 . . . . . $136
Opt 02, 9 ft, Order 010-6062-15 . . . . . $136

P6063B Dc to 200 MHz
1X, 10X Selectable Attenuation



The P6063B is a fast-rise dual attenuation, passive probe designed for Tektronix Oscilloscopes with bandwidths greater than 100 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multitrace display. The P6063B can be compensated with instruments having a nominal input capacitance of 15 to 24 pF.

The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

SPECIFICATIONS

Attenuation — 10X and 1X. **Input Resistance** — 1X position, 1 MΩ, 10X position, 10 MΩ ±0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input Capacitance** — 3.5 ft probe cable is 80 pF in the 1X position, 11 pF in the 10X position; 6 ft version is 105 pF in the 1X position, and 14 pF in the 10X position. **Bandwidth** — 10X probe (3.5 ft and 6 ft versions) is at least 200 MHz when used with an oscilloscope with a bandwidth greater than 225 MHz. 1X probe for the 3.5 ft version is at least 12 MHz and for the 6 ft version at least 6 MHz. **Voltage Rating** — 500 V (dc + peak ac), derated with frequency.

INCLUDED ACCESSORIES

352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** hook probe (CK)
013-0107-03	1 **TIP,** probe, retractable (BS)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00	2 **CLIP,** alligator (AU)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
016-0521-00	1 **POUCH,** accessory

ORDERING INFORMATION

P6063B Switchable Attenuation Probe, 6 ft,
Order 010-6063-13 . . . . . $160
Opt 01, 3.5 ft, Order 010-6063-11 . . . . . $160

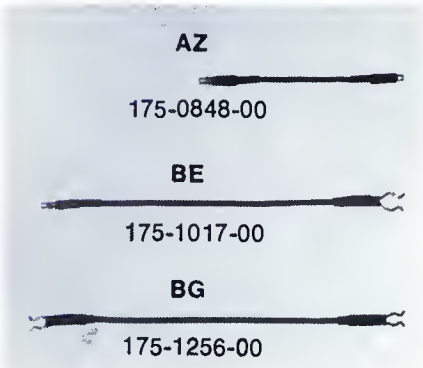
Probe Accessories

Modular Probe Replacement Parts

Probe	Length	Probe Head	Probe Cable	Compensator/Connector
P6101	1 Meter	206-0223-00 $16	175-1661-00 $23	103-0189-00 $16
	2 Meter	206-0223-00 $16	175-1661-01 $23	103-0189-00 $16
	3 Meter	206-0223-00 $16	175-1661-02 $23	103-0189-00 $16
P6105*	1 Meter	206-0216-00 $39	175-1661-00 $23	206-0219-00 $38
	2 Meter	206-0217-00 $39	175-1661-01 $23	206-0220-00 $38
	3 Meter	206-0218-00 $39	175-1661-02 $23	206-0221-00 $38
P6106*	1 Meter	206-0216-00 $39	175-1661-00 $23	206-0237-00 $55
	2 Meter	206-0217-00 $39	175-1661-01 $23	206-0238-00 $60
	3 Meter	206-0218-00 $39	175-1661-02 $23	206-0239-00 $60
P6107	2 Meter	206-0217-00 $39	175-1661-00 $23	206-0247-00 $40
P6108	1 Meter	206-0224-00 $33	175-1661-00 $23	206-0227-00 $35
	2 Meter	206-0225-00 $33	175-1661-01 $23	206-0228-00 $38
	3 Meter	206-0226-00 $33	175-1661-02 $23	206-0229-00 $38
P6149	2 Meter	206-0234-00 $33	175-1661-01 $23	206-0235-00 $40

*The BNC Connector with readout may be replaced with 131-1799-01

Probe Ground Leads



#6-32 Probe Tips and Accessories

The following tips and adapters can be used on all Tektronix Probes that accept a #6-32 screw-on tip, including the P6006, P6007, P6008, P6009, P6028, and P6060 Probes.

CODE	DESCRIPTION	PART NUMBER	PRICE
AA	Bayonet ground assembly	013-0052-00	$ 5.75
AB	Probe tip to BNC adapter	013-0054-00	14.00
AC	Probe tip to BNC adapter (for P6028)	013-0056-00	15.00
AD	Probe retractable hook tip	013-0071-00	2.75
AE	Probe retractable hood tip	013-0071-01	3.00
AF	Probe banana tip	134-0013-00	.60
AG	Probe ground cover (for P6009)	166-0428-00	1.10
AH	Probe straight tip (0.055 in dia)	206-0015-00	.60
AI	Probe spring tip (0.080 in dia)	206-0060-00	.95
AJ	Probe spring tip (accepts .065 in dia pin)	206-0061-00	.75
AK	Probe calibration tip (0.063 in dia)	206-0100-00	8.75
AL	Probe long straight tip (0.032 in dia)	206-0104-00	.90
AM	Probe hook up	206-0105-00	.90
AN	Probe pin tip (accepts 0.025 in IBM SLT in)	206-0134-00	3.50
AO	Probe ground lead adapter (#6-32 to 0.025 in square pin)	206-0137-01	1.50
AP	Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	2.00
AQ	Probe right angle hook tip	206-0185-00	1.15
AR	IC test tip	206-0203-00	1.10
AS	Alligator clip	344-0005-00	3.25
AT	Alligator clip	344-0045-00	1.10
AU	Miniature alligator clip	344-0046-00	1.10

CODE	DESCRIPTION	LENGTH (in)	PART NUMBER	PRICE
AV	Ground lead*	3	175-0263-01	$ 1.75
AW	Ground lead*	5	175-0124-01	1.75
AX	Ground lead*	12	175-0125-01	1.75
AY	Ground lead for S-3A, P6056, P6057	3	175-0249-00	3.75
AZ	Ground leads for P6054, P6054, P6075	3	175-0848-00	1.35
BA	7A11, and P6201	5	175-0848-01	1.40
BB		12	175-0848-02	1.40
BC	Ground leads for P6202 and P6420	3	175-0849-00	5.00
		6	175-0849-01	5.00
BD	Ground lead for P6008 Environmental	12	175-0925-00	3.00
BE	Ground leads for S-3A, P6202,	6	175-1017-00	2.60
BF	and P6420	12	175-1018-00	2.60
BG	Ground lead for P6055	6	175-1256-00	4.00
BH	High-voltage dielectric fluid		252-0120-00	4.00

*For the P6053B, P6054A, P6075A, P6101, P6105, P6106, P6108, P6149, and other probes requiring clip-on ground leads.

CABLE MARKER SETS (Not Pictured)

DESCRIPTION	PART NUMBER	PRICE
For 1/8 in dia cable	016-0130-00	$5.00
For 3/16 in dia cable	016-0127-00	3.75
For modular cable	016-0633-00	3.75

Slip-on Probe Tips and Adapters

The following tips and adapters are designed for use with Tektronix Miniature Probes and accept a slip-on tip.

CODE	DESCRIPTION	PART NUMBER	PRICE
BI	Probe tip extractor	033-0825-00	$ 1.60
BJ	Termination, 50 ohm	011-0049-01	25.00
BK	Probe tip to BNC adapter for all probes	013-0084-01	8.00
BL	Probe tip to BNC adapter for all, except P6202	013-0084-02	10.00
BM	Bayonet ground assembly	013-0085-00	5.50
BN	Retractable hook tip (for P6010 and P6048)	013-0090-00	3.25
BO	Retractable hook tip (for S-3A, P6202, and P6420)	013-0097-01	5.75
BP	Retractable hook tip (for all modular probes)	013-0105-00	5.75
BQ	Retractable hook tip (for 7A11 and P6401)	013-0106-00	7.75
BR	Retractable hook tip (for 211, 212, 213, 214, 221)	013-0107-00	2.75
BS	Retractable hook tip (for P6053B, P6055, P6062B, P6063B, P6101, P6105, P6106, P6108, and P6149)	013-0107-03	2.75
BT	Retractable probe tip (for P6201 only)	013-0135-00	3.25
BU	Probe tip to BNC adapter (for P6201 only)	013-0145-00	12.00
BV	Miniature probe tip cover, IC tester, Package of 10	015-0201-03	2.50
	Package of 100	015-0201-04	10.00
BW	Miniature probe tip to GR adapter	017-0076-00	32.00
BX	Miniature probe tip to GR 50 Ω termination adapter	017-0088-00	44.00
BY	P6201 probe tip to GR 50 Ω termination adapter	017-0094-00	38.00
BZ	Miniature probe to #6-32 adapter (for P6045, P6046, P6202, 7A11, S-3A)	103-0051-00	3.25
CA	Miniature probe to #6-32 adapter (for all miniature probes except P6045, P6202, includes all modular probes)	103-0051-01	3.25
CB	Female to dual banana adapter, BNC	103-0090-00	7.50
CC	Miniature probe to #6-32 adapter with ground connection	103-0131-00	4.50
CD	Probe tip to test point jack (for P6201 only)	103-0164-00	4.50
CE	Probe tip flexible, adapts miniature probe to retractable hook tip (CY)	103-0177-01	5.50
CF	Chassis mount test jack (for miniature probes, including modular)	131-0258-00	3.50
CG	Ground contact (for P6201 only)	131-1302-00	.70
CH	Miniature probe tip ground cover, insulating sleeve (for all miniature probes, including modular)	166-0404-01	.25
CI	Ground lead, insulating sleeve (for P6201 only)	166-0433-00	.75
CJ	Insulating sleeve, electrical (for P6201 only)	166-0557-00	.30
CK	Probe tip hook (for all miniature probes, including modular)	206-0114-00	2.30
CL	Probe tip straight (for all miniature probes, including modular)	206-0114-01	2.30
CM	Replaceable probe tip, pkg of 10. All miniature probes including modular except P6202 and P6420	206-0191-03	14.00
CN	Probe tip flexible for 0.025 sq pin	206-0193-00	6.50
CO	Replaceable probe tip (for P6201 only)	206-0200-00	.30
CP	Probe pin tip (accepts 0.025 in IBM SLT pin)	206-0209-00	2.90
CR	Replaceable probe tip for P6202 and P6420, pkg of 10	206-0230-03	13.00
CS	Electrical contact	214-0283-00	.60
CT	Ground contact insulator (for P6201 only)	342-0180-00	.45
CU	Adjustment tool, probe	003-0675-01	1.20
CV, CW, and CX	Coaxial cable—see page 290.		
CY	Miniature retractable hook tip	206-0222-00	2.75
CZ	Dual lead adapter for miniature probes	015-0325-00	9.50
DA	Probe tip accessory	206-0252-00	15.00

Make Floating Measurements

And Create a Safer Working Environment... With Isolation Accessories from Tektronix.

With two new isolation accessories from Tektronix you can make floating measurements . . . and minimize the risk of injury to operators or damage to test equipment. Both accessories meet worldwide safety standards, including UL 1244, CSA Electronics Bulletin 556B, IEC348, BS 4743 and VDE 0411.

Why Make Floating Measurements?

Floating measurements. . . that is, measurements made without reference to ground. . . are required in many situations, typically when signal voltage exceeds the test instrument's input rating or when the signal range is very small in proportion to the offsetting voltage.

Floating measurements can be hazardous to the test equipment operator who has disconnected the protective ground of the equipment or is unaware of a component failure in the equipment. In either case, the result could be an injurious or lethal shock.

These measurements can also damage or destroy the test equipment or the circuit under test through voltage or current overload. For example, Tektronix will not repair or calibrate an instrument whose protective ground lead and connection have been defeated to make floating measurements. Tektronix will replace the power cord assembly and then perform maintenance.

Finally, measurements can be difficult to perform because probes or connectors can introduce unwanted circulating currents, or ground loops, into the circuit under test. Circulating currents impose noise on the desired signal, and they can interfere with system operation through the connection of the probe ground.

Common Floating Measurement Techniques.

Floating measurements can be made in several ways. Each method has limitations, and some are safer and more reliable than others.

One method isolates the test equipment from ground by introducing a device such as the Tektronix A6901 Ground Isolation Monitor. The A6901 approach to disconnecting the ground lead maintains the integrity of the test equipment's protective ground path. When voltages greater than 40 V peak and currents greater than 0.5 mA are applied to the floating test instrument, the A6901 interrupts power to the test instrument and re-establishes the connection to ground within 20-30 ms. The A6901 is inexpensive, and imposes no performance limitations on the test instrument.

Another often-used method isolates the signal and the common connection from the test equipment typically by placing transformers or capacitors in the signal and common paths. This approach allows the test instrument to remain grounded, but means that only ac measurements can be made, and these only at lower frequencies. Also, it can be very difficult to maintain system bandwidth at high voltages.

A third method uses an optically coupled circuit, which provides good isolation at high voltages and low signal interference. This approach is limited in that it is nonlinear and temperature dependent.

The A6902 Isolator, which combines the signal transformer approach with optical coupling, is a sophisticated example of these two methods and achieves a high degree of voltage isolation while preserving bandwidth and linearity.

A fourth method isolates the system under test from ground with an isolation transformer. System performance is maintained, but the operator must be protected as excessive voltage may be present in its chassis. This approach is not always viable, and isn't capable of high-voltage isolation.

A fifth method uses a differential amplifier such as the Tektronix model 7A13 (see page 114). This method requires two matched probes and imposes voltage and bandwidth limitations at higher frequencies.

A sixth method uses a battery operated test instrument such as the Tektronix 200 Series Oscilloscopes (see pages 162-164) to avoid the necessity of grounding the test instrument chassis. Tektronix 200 Series Instruments are double insulated, but caution should be observed when connecting the probe to test points.

A hybrid approach is to permanently install a dedicated circuit for floating measurements in the device under test, based on one of the methods described above such as the Tektronix CT-1 and CT-2 Current Transformers.

Two New Isolation Accessories

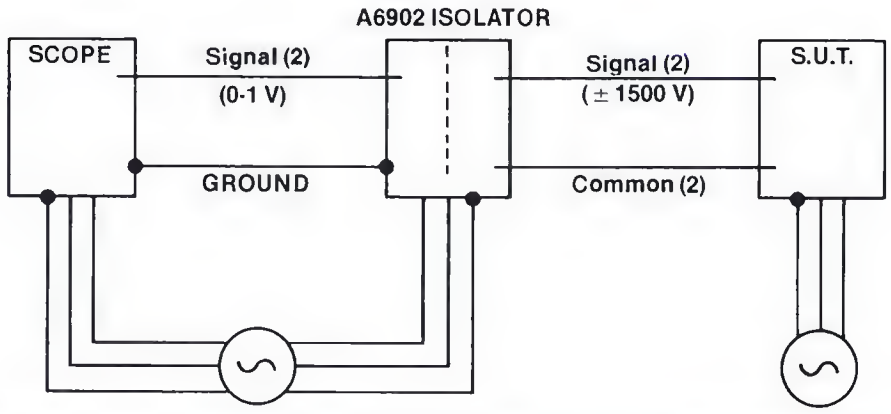
The A6901 Ground Isolation Monitor, for low-voltage, high-frequency floating measurements such as those made in digital design and service, re-establishes protective ground to the test instrument when excessive voltage is applied. The A6902 Isolator, for mid-frequency, high-voltage measurements such as those made in high power semiconductors testing or motor controls applications, permits floating measurements at high voltages.

The A6901 Ground Isolation Monitor is unique to Tektronix, and the A6902 Isolator is a state-of-the-art improvement over similar devices. Both accessories offer superior isolation over techniques currently in use.

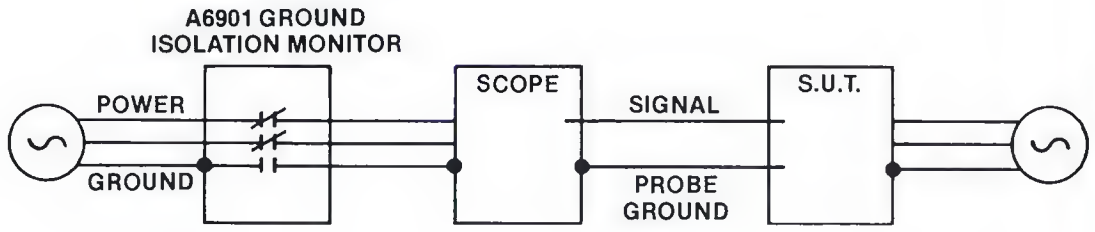
The A6901 Ground Isolation Monitor, which connects between the source of power and the test instrument, allows you to reference your oscilloscope through its common lead to as much as 28 V RMS (40 V ac peak), ±40 V dc. Should excessive voltage be applied to the test instrument common lead, the Ground Isolation Monitor interrupts power to the test instrument and re-establishes connection to ground, typically within 20-30 ms. The A6901 imposes no performance limitations on your test equipment and is relatively inexpensive.

The A6902 Isolator, which acts as a buffer between the device under test and the test instrument (such as an oscilloscope), extends the voltage range of the test device to ± 1500 V (dc + peak ac) with the large probe, and to ±500 V (dc + peak ac) with the smaller probe. It may impose bandwidth and voltage limitations on your measurement system, as shown in the graph on next page. The A6902 isolates signals from the test instrument through a combination of optical and transformer coupling. This isolation technique, plus the all-plastic case construction and controls, protect the operator from exposure to high voltage levels when setting A6902 controls; access to the grounded test instrument is unimpeded. The A6902 is relatively expensive.

For more information on these new accessories, contact your local Tektronix Sales Engineer in the second quarter of 1981.



The A6902 Isolator isolates the signal *and* common from both green ground and the scope chassis to 1500 V dc plus peak ac and allows low level measurements to be made over a range of 20 mV to 200 V per division.



The A6901 Ground Isolation Monitor interrupts the green ground lead allowing the chassis of the oscilloscope to float at voltages below 40 V Peak (the UL approved safe limit).

Isolation Accessories

NEW A6901 Ground Isolation Monitor

Automatically tests green ground continuity.

Allows power to reach isolated system and disconnects green ground from the isolated system.

Monitors the voltage difference between the test instrument chassis and ground.

40 V (30 V RMS) peak difference between chassis and ground, or loss of ground continuity, re-establishes chassis to green ground connection.

Complies with UL, IEC, CSA, VDE standards.

Compact, portable.

SPECIFICATIONS
ELECTRICAL CHARACTERISTICS

Dc Trip Voltage — 28 V RMS (40 V peak) or ±40 V dc ±5%.

Current Trip — ±0.5 mA, ±3.5 mA, and ±5 mA maximum selectable.

Neutral-to-Ground Continuity — 5 V RMS nominal.

Dc Voltage Trip Delay — Less than 200 ms.

Line Voltage Ranges (RMS) — 90-128 V; 180-250 V.

Line Frequency Range — 48-66 Hz.

Maximum Power Consumption (no external load) — 6 W at 115 V, 60 Hz.

Load Power — 90-128 V, 500 W max; 180-250 V, 500 W max.

ENVIRONMENTAL CHARACTERISTICS

Temperature
Operating — −15°C to +55°C
Storage — −62°C to +85°C

Altitude
Operating — to 4.5 km (15,000 ft)
Storage — to 15 km (50,000 ft)

PHYSICAL CHARACTERISTICS

Dimensions	in	cm
Height	3.2	8.1
Width	6.0	15
Length	8.0	20
Weights	**lb**	**kg**
Net	3.0	1.4
Shipping	5.0	2.3

NEW A6902 Isolator

Two probe sizes and ratings (1500 V and 500 V) interchangeable via quick disconnect.

Dc to 15 MHz bandwidth. (Requires voltage derating at high frequencies.)

Dual channel operation with offset and volts/division controls for each channel.

Plastic case and controls for operator safety.

Side pouches store input probes and output cables.

Two isolated channels may be used simultaneously, referenced to different common voltages.

Floating inputs meet UL, IEC, CSA and others.

SPECIFICATIONS
ELECTRICAL CHARACTERISTICS

Deflection Factor
Sensitivity — 20 mV/div to 200 V/div in a 1-2-5 sequence with oscilloscope set to 10 mV/div.

Accuracy — ±3% of indicated VOLTS/DIV switch setting.

Maximum Working Voltage
Larger Probe — Probe center tip to earth ground — 1500 V (dc + peak ac). Pulse tested at 4.4 kV for 1 sec.

Probe center tip to probe common — 1500 V (dc + peak ac) to 700 kHz derated to 72 V (dc + peak ac) at 15 MHz.

Probe common to earth ground — 1500 V (dc + peak ac) to 400 kHz derated to 510 V (dc + peak ac) at 5.8 MHz.

Smaller Probe — Probe center tip to earth — 500 V (dc + peak ac).

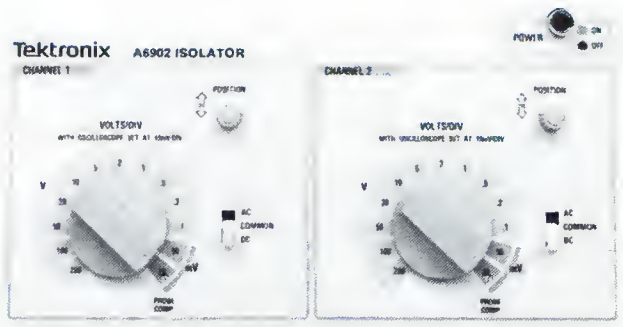
Probe center tip to probe common — 500 V (dc + peak ac) to 2 MHz derated to 72 V (dc + peak ac) at 15 MHz.

Probe common to earth ground — 500 V (dc + peak ac) derating to 200 V (dc + peak ac) at 15 MHz.

PROBE AND AMPLIFIER CHARACTERISTICS

Frequency Response — Bandwidth, dc coupled (to −3 dB Point) — ≥15 MHz. Lower −3 dB Point, ac coupled — ≤1 Hz.

Transient Response — Rise Time — 23 ns or less.



Input Impedance
Resistance — 10 MΩ within 3%.

Capacitance
Larger Probe (1500 V) — ≈21 pF.
Smaller Probe (500 V) — ≈17.4 pF.

Output Impedance — ≈50 Ω.

Common Mode Capacitance — ≈150 pF from probe common to earth ground.

Tangential Noise — 2.0 mV.

Dc Drift with Temperature — ≤1 mV/°C or 0.1 div/°C at output.

Common Lead Signal Feedthrough — −106 dB from probe input to output bnc when used with an oscilloscope having a 1 MΩ input resistance end up to 47 pF input capacitance. Derated to −80 dB at 1020 Hz and derated to −50 dB at 15 MHz.

POWER SOURCE CHARACTERISTICS

LIne Voltage Range (RMS)
Low — 90 to 132 V.
High — 180 to 250 V.

Line Frequency Range — 48 to 440 Hz.

Power Consumption, Maximum — 15 W at 115 V, 60 Hz.

ENVIRONMENTAL CHARACTERISTICS

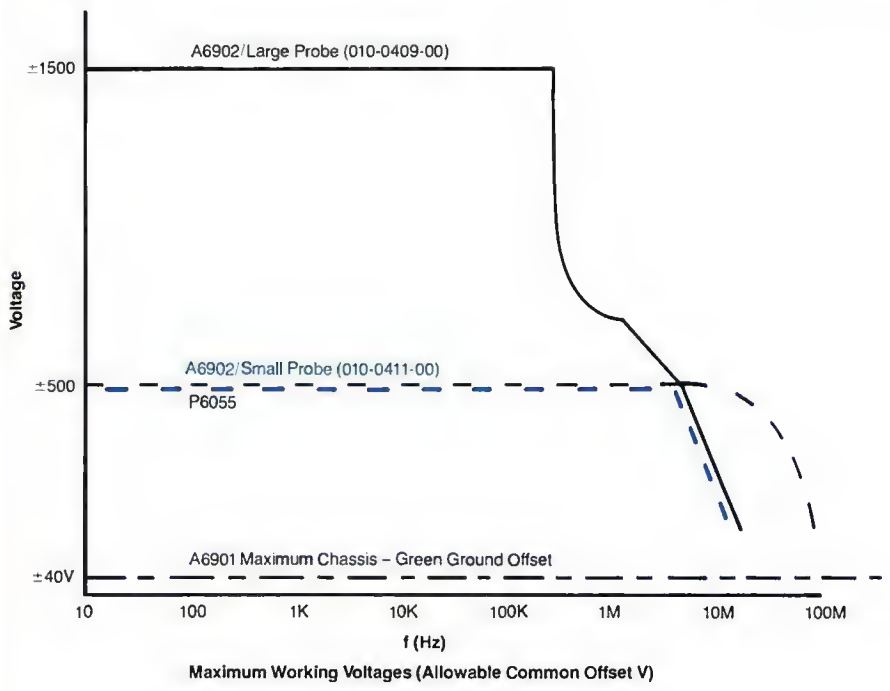
Temperature
Operating — −15°C to +55°C.
Storage — −62°C to +75°C.

Altitude
Operating — To 4.5 km (1500 ft).
Storage — To 15 km (50,000 ft).

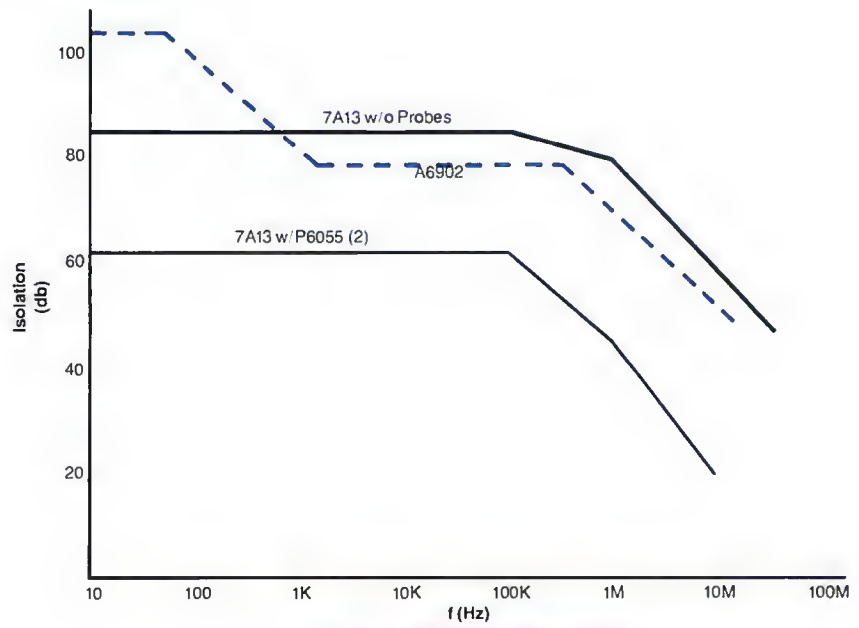
PHYSICAL CHARACTERISTICS

Dimensions	in	cm
Height	5.35	13.6
Width	15.6	39.4
Length	13.5	34.4
Weights (with accessories)	**lb**	**kg**
Net	13	5.7
Shipping	17	7.5

For more information on these new accessories, contact your local Tektronix Sales Engineer in the second quarter of 1981.



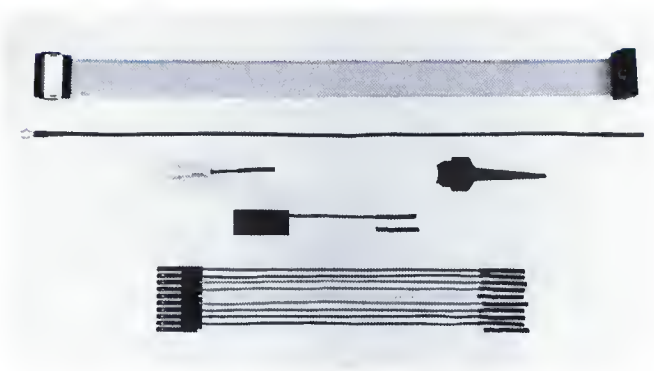
Maximum Working Voltages (Allowable Common Offset V)



Common Lead Signal Feedthrough
Common Mode Rejection Ratio (CMRR)

Adapting and Connecting Accessories

LOGIC PROBE TEST LEADS



16 pin low profile dip clip (can be used with 14 or 16 pin ICs)	015-0330-00	$25.00
10 wide comb set with grabber tips not included	012-0747-00	40.00
Miniature retractable hook tip	206-0222-00	2.75
Dual lead adapter for miniature probes	015-0325-00	9.00
Flexible probe tip, P6006 type	103-0210-00	5.00
Ground lead, P6006 type	195-0234-00	4.50

PATCH CORDS

BNC to BNC, 18 in		
Red	012-0087-00	$3.75
Black	012-0086-00	3.75
BNC to banana plug-jack, 18 in		
Red	012-0091-00	$3.75
Black	012-0090-00	3.75
Banana plug-jack to banana plug-jack, 18 in		
Red	012-0031-00	$3.75
Black	012-0039-00	3.75

Pin-jack to pin-jack, 0.08 in dia pin		
Red, 8 in	012-0179-00	$3.50
Red, 18 in	012-0180-00	3.50
Black, 8 in	012-0181-00	3.50
Black, 18 in	012-0182-00	3.50

TEST LEADS

Test Lead, Black, 4 ft	012-0425-00	$ 8.00
Test Lead, Red, 4 ft	012-0426-00	12.50
Test Lead, Black, 4 ft	012-0426-01	12.50
Test Lead set includes 012-0425-00, 012-0426-00, and 013-0107-03	012-0427-00	21.00

PERSONALITY MODULE TEST LEADS

40 Pin Dip Clip—10 cm cable (order M/F adapter below)	015-0339-00	$40.00
40 Pin Dip Clip—30 cm cable Male Adapter for 40 Pin (order M/F adapter below)	015-0339-02	40.00
Low Profile Dip Clip—for use with PM101/7D02 General Purpose Personality Module (or with individual leads such as the 10-wide comb set 012-0747-00)	380-0560-05	6.25
Female Adapter for 40 Pin Low Profile Dip Clip—for use with dedicated 7D02 personality modules	380-0647-01	35.00

COAXIAL CABLES

BNC Connectors

Coaxial, 50 Ω, 42 in	012-0057-01	$17.00
Coaxial, 75 Ω, 42 in	012-0074-00	17.00
Coaxial, 93 Ω, 42 in	012-0075-00	17.00
Coaxial, 50 Ω, 18 in	012-0076-00	17.00
Coaxial, 50 Ω, 18 in, Male to Female	012-0104-00	20.00
Coaxial, 50 Ω Precision, 36 in	012-0482-00	25.00

N Connectors 50 Ω

Coaxial N connectors, 6 ft	012-0114-00	$25.00

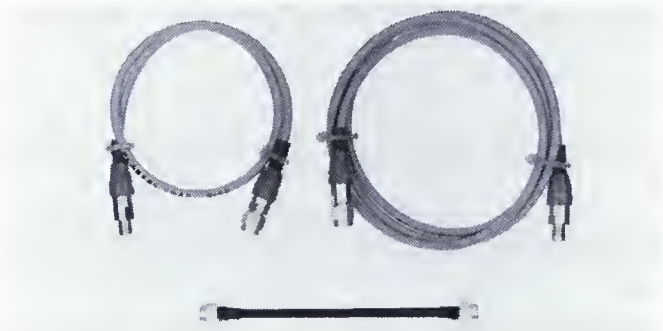
GR Connectors 50 Ω

Coaxial 10 ns RG58A/U	017-0501-00	$65.00
Coaxial 5 ns RG213/U	017-0502-00	150.00
Coaxial 1 ns RG58A/U*	017-0503-00	100.00
Coaxial 20 ns RG213/U	017-0504-00	75.00
Coaxial 2 ns RG58A/U	017-0505-00	90.00
Coaxial 5 ns RG58A/U	017-0512-00	65.00
Coaxial 10 in RG213/U	017-0513-00	65.00
Coaxial 20 in RG213/U	017-0515-00	70.00

*Connector on one end only.

50 Ω CABLES

SMA (3 mm) Connectors 50 Ω

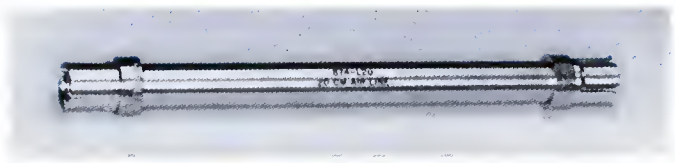


Coaxial 2 ns	015-1005-00	$ 80.00
Coaxial 5 ns	015-1006-00	130.00
Coaxial semirigid 500 ps	015-1015-00	40.00
Coaxial semirigid 750 ps	015-1017-00	35.00
Coaxial 1 ns	015-1019-00	105.00

BNC to BSM Connectors 50 Ω

Coaxial, 10 in, RG58 BSM Female to BNC Male	012-0128-00	$17.00
Coaxial, 18 in, RG58 BSM Female to BNC Male	012-0127-00	17.00

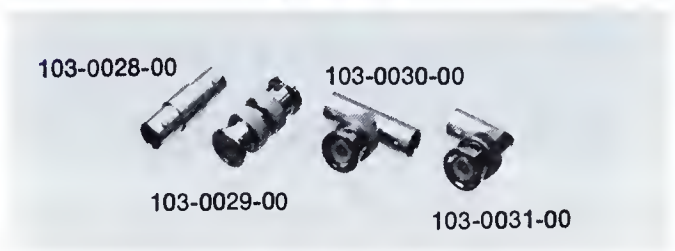
50 Ω AIR LINE



The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50 Ω Air Line	017-0084-00	$115.00

ADAPTERS



BNC Female to BNC Female	103-0028-00	$ 5.00
BNC Male to BNC Male	103-0029-00	5.50
BNC T	103-0030-00	6.50
BNC Elbow Male to Female	103-0031-00	6.00

BNC Male to GR	017-0064-00	$35.00
BNC Male to uhf Female	103-0032-00	4.75
BNC Male to Binding Post	103-0033-00	4.75
BNC Male to Dual Binding Post	103-0035-00	12.00
BNC Male to N Female	103-0058-00	7.00

BNC Female to clip leads	013-0076-00	$17.50
BNC Female to GR	017-0063-00	25.00
BNC Female to uhf Male	103-0015-00	4.50
BNC Female to BSM Male	103-0036-00	15.00
BNC Female to N Male	103-0045-00	6.50
BNC Female to Dual Banana	103-0090-00	7.50

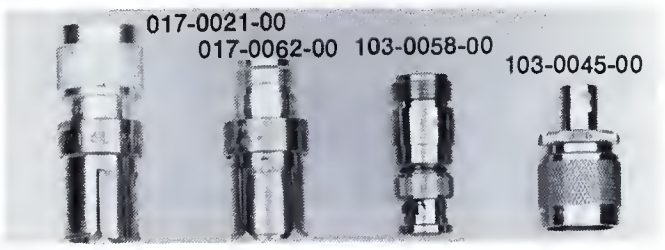
BNC Female to EZ Ball	013-0076-01	$17.50

GR to N Male	017-0021-00	$25.00
GR to C Male	017-0027-00	40.00
GR to N Female	017-0062-00	32.00
GR to C Female	017-0065-00	35.00

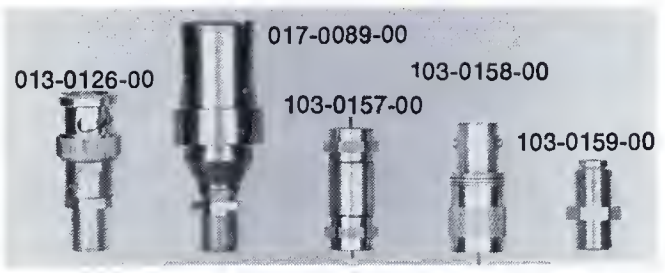
GR to BNC Female	017-0063-00	$25.00
GR to BNC Male	017-0064-00	35.00
50 Ω termination, thru-line	017-0083-00	80.00

*(GR to BNC Male)

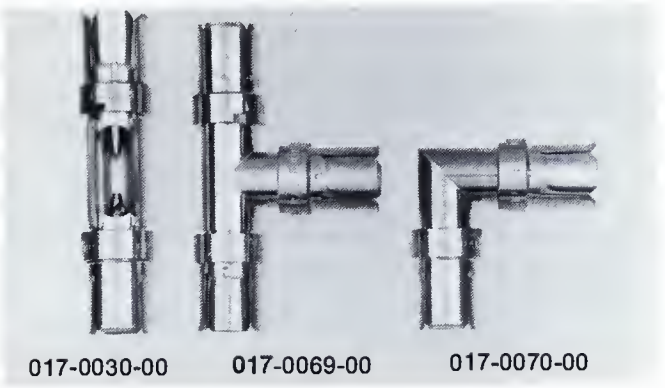
*Upper frequency limit vswr not specified



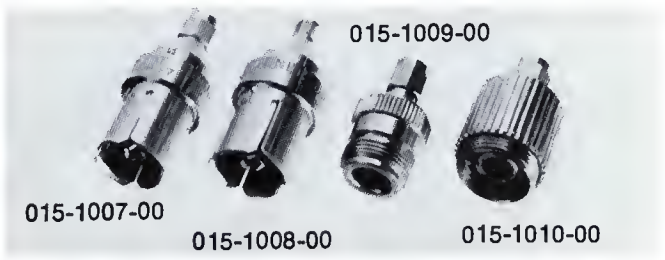
N Male to GR	017-0021-00	$25.00
N Female to GR	017-0062-00	32.00
N Male to BNC Female	103-0045-00	6.50
N Female to BNC Male	103-0058-00	7.00



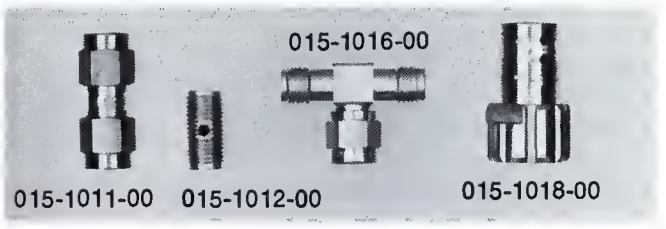
"F" Female to BNC Male	013-0126-00	$15.00
"F" Female to GR874	017-0089-00	35.00
"F" Male to "F" Male	103-0157-00	7.50
"F" Male to BNC Female	103-0158-00	8.50
"F" Female to "F" Female	103-0159-00	7.50



GR Insertion Unit	017-0030-00	$70.00
GR T	017-0069-00	80.00
GR Elbow	017-0070-00	75.00



SMA Male to GR	015-1007-00	$ 50.00
SMA Female to GR	015-1008-00	55.00
SMA Male to N Female	015-1009-00	50.00
SMA Male to 7 mm APC	015-1010-00	175.00



SMA Male to Male	015-1011-00	$20.00
SMA Female to Female	015-1012-00	16.00
SMA T	015-1016-00	30.00
SMA Male to BNC Female	015-1018-00	8.00

ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing	011-0081-00	$30.00

ATTENUATORS—TERMINATIONS

50 Ω ±0.1% precision feedthrough termination (dc —100 kHz, 11 V rms max)	011-0129-00	$75.00
50 Ω feedthrough termination[1]	011-0049-01	25.00
50 Ω 10X (20 dB) attenuator[2]	011-0059-02	35.00
50 Ω 5X (14 dB) attenuator[2]	011-0060-02	35.00
50 Ω (6 dB) attenuator[2]	011-0069-02	35.00
50 Ω 2.5X (8 dB) attenuator[2]	011-0076-02	35.00
50 Ω feedthrough termination (5 W)[3]	011-0099-00	40.00

Characteristics—Dc resistance is 50 Ω ± 1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

vswr

[1]Less than 1.1 dc—250 MHz and less than 1.2 dc—500 MHz.

[2]Less than 1.1 dc—1.0 GHz and less than 1.2 dc—2.0 GHz.

[3]1.1 dc—100 MHz.

75 Ω feedthrough termination	011-0055-00	$25.00
93 Ω feedthrough termination	011-0056-00	25.00
50 Ω to 75 Ω min loss attenuator	011-0057-00	25.00
50 Ω to 93 Ω min loss attenuator	011-0058-00	25.00
75 Ω 10X attenuator	011-0061-00	30.00
93 Ω 10X attenuator	011-0062-00	28.00
600 Ω feedthrough termination (1 W, dc to 1 MHz)	011-0092-00	30.00
75 Ω to 50 Ω min loss attenuator (ac coupled)	011-0112-00	60.00

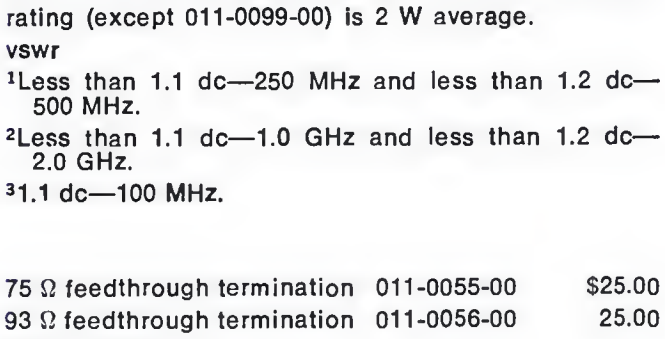
CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at dc.

Power rating of attenuators is ½ W and terminations 1 W.

Voltage standing wave ratio (vswr) not specified.

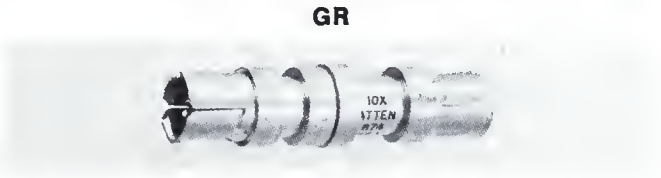
ATTENUATORS and TERMINATORS



Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. impedance is 50 Ω.

10 dB attenuator	011-0085-00	$70.00
20 dB attenuator	011-0086-00	70.00
40 dB attenuator	011-0087-00	90.00

GR



50 Ω 10X attenuator	017-0078-00	$120.00
50 Ω 5X attenuator	017-0079-00	120.00
50 Ω 2X attenuator	017-0080-00	120.00
50 Ω termination, end-line	017-0081-00	90.00

CHARACTERISTICS

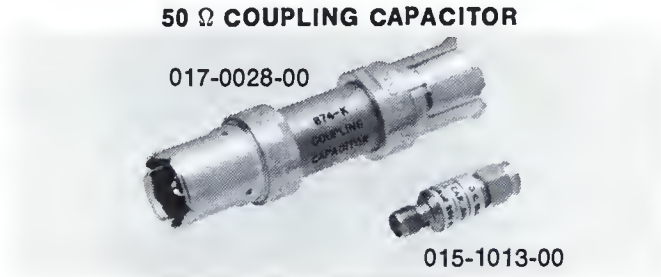
Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (vswr) is less than 1.1 up to 1 GHz. Power rating is 1 W.

50 Ω 2X attenuator	015-1001-00	$120.00
50 Ω 5X attenuator	015-1002-00	120.00
50 Ω 10X attenuator	015-1003-00	120.00
50 Ω termination Female	015-1004-00	60.00
Short-Circuit termination Male	015-1020-00	17.50
Short-Circuit termination Female	015-1021-00	24.00
50 Ω termination Male	015-1022-00	32.00

CHARACTERISTICS

	Dc — 12.40 GHz		12.41 — 18.00 GHz		Power
	Atten Accuracy	Vswr	Atten Accuracy	Vswr	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W

50 Ω COUPLING CAPACITOR



The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150 ps tdr system), max is 0.03. Voltage rating is 200 V.

Coupling Capacitor SMA (3 mm)	015-1013-00	$150.00

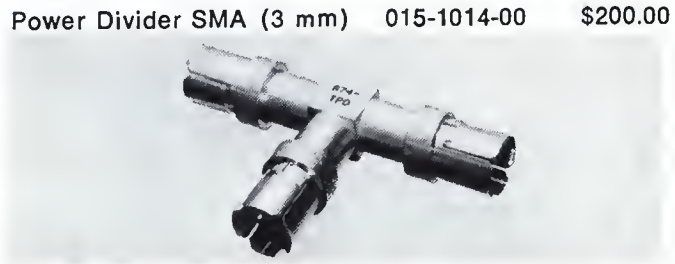
The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor GR	017-0028-00	$60.00

50 Ω POWER DIVIDERS

This coaxial tee is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Max vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

Power Divider SMA (3 mm)	015-1014-00	$200.00



This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Power Divider GR	017-0082-00	$225.00

Digital Accessories

A6701 Word Recognizer

- **Gate Emulation: AND, NAND, OR, NOR**
- **Expandable in 18 Bit Increments**
- **1 to 18 Bits at 50 MHz Clock Rate**
- **Up to 72 Bits @ 15 MHz Clock Rate**
- **Accommodates all Logic Families**
- **Synchronous Qualified Clock and Level Modes**
- **Glitch Filter**

The new A6701 18 Bit Word Recognizer provides easy-to-use, uniquely configurable gate emulated triggering for digital troubleshooting. Besides conventional AND word recognition, the A6701 can be configured to provide NAND, OR, NOR or a combination of user-defined logic triggering. Both synchronous and asynchronous modes are provided along with such features as WORD-$\overline{\text{WORD}}$ selection, threshold voltage selection and glitch filter. In the synchronous mode, you may select either a level or qualified clock output.

CHARACTERISTICS

CONTROL POD

Input RC—1 MΩ paralleled by 5 pF.

Threshold Voltage—
TTL—Fixed at 1.4 V.
VAR—±12 V.

Minimum Input Swing—500 mV p-p (±2% of threshold voltage) or less centered about the threshold voltage.

Maximum Clock Rate—1-18 channels—50 MHz.

Clock Input—Minimum clock pulse width 1-18 channels—10 ns high, 10 ns low.

Data and Qualifier Inputs—
SYNC QUALIFIED CLOCK or SYNC-LEVEL MODE—1-18 channels
Minimum setup time—16 ns or less.
Delay time for output to change states following the coincidence of a word pattern match and the selected clock edge—Max. 17.0 ns., typical 13.5 ns, min. 10.0 ns.
ASYNC-GLITCH FILTER OFF MODE—1-18 channels
Minimum input pulse width for ≥5 ns output—10 ns or less, any single channel; 15 ns or less, any combination of channels.
Maximum input delay difference between channels—7 ns.
Delay time from probe tip to trigger output connectors—Max 20.0 ns, typical 16.5 ns, min. 10.0 ns.
SYNC-GLITCH FILTER ON MODE—Filter continuously variable from <5 ns to >250 ns.

Trigger Output (BNC and Trig Out Square-Pin)—
HI Level—≥2.2 V (1.1 V into 50Ω load).
LO Level—≤0.6 V.
Output Impedance—50Ω

Expansion Output—
Level—Standard ECL level terminated at expansion input of next module.
Delay from probe tip to expansion output BNC—Max. 19.5 ns, typical 15.5 ns, min. 9.0 ns.

POWER SUPPLY

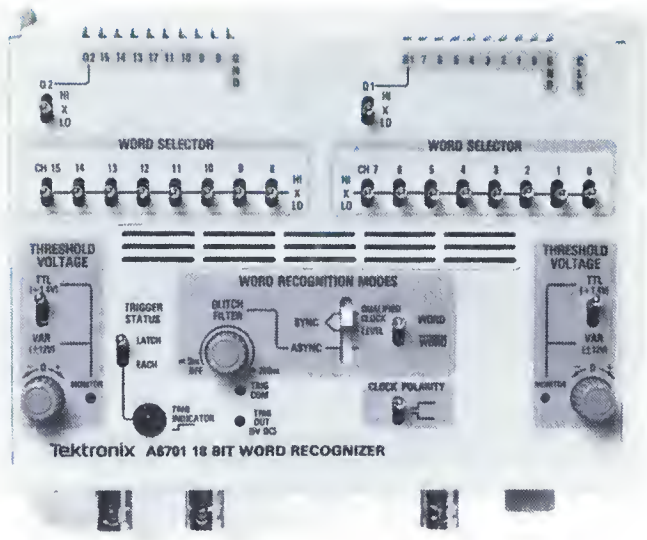
The separate power supply module can power two 18 Bit word recognizer pods.

Line voltage is selected by changing the line voltage selector card to operate on 115 V system or 230 V system.

Frequency—48-440 Hz.
Max. Power Consumption—29 W.
Operating Temperature—0°C to 50°C.

PHYSICAL CHARACTERISTICS

	Word Recognizer Unit	Power Supply Unit
Weight	**1 lb (0.45 kg)**	**4.5 lbs (2.0 kg)**
Dimensions		
Length	6.5 in (16.3 cm)	8.0 in (20.0 cm)
Height	1.7 in (4.3 cm)	3.2 in (8.0 cm)
Width	4.75 in (11.9 cm)	6.0 in (15.0 cm)



INCLUDED ACCESSORIES

1	016-0451-00	Carrying Case (A)
1	016-0537-00	Pouch, Accessory (B)
1	012-0482-00	Cable Assembly, 50 Ω BNC (C)
1	195-0277-00	Lead, Electrical (D)
21	206-0222-00	Tip, Probe: Microcircuit Test (E)
1	012-0848-00	Dc Power Cord (F)
2	012-0747-00	Lead Set, 10-Wide (G)
1	161-0066-00	Power Cord, 125 V ac
1	159-0031-00	Fuse, 0.4 A Slow-Blow
1	159-0044-00	Fuse, 0.2 A Slow-Blow

ORDERING INFORMATION

A6701 18 Bit Word Recognizer (with accessories and power supply) $1380

A6701 Option 01 18 Bit Word Recognizer (with accessories, without power supply) Note: Requires A6701 above for 36 bits parallel word recognition .....Sub $325

015-0356-00 Power Supply $325

OPTIONAL ACCESSORIES

012-0800-00	P6451 to 10-Wide Connector
012-0209-00	Lead Set With Hook Tip, 40 CM (10 Leads)
012-0655-01	Lead Set, 40 CM (10 Leads)
012-0655-02	Lead Set, 20 CM (10 Leads)
015-0330-00	Dip Clip, Low Profile (16 Pin)
103-0209-00	P6451 to GPIB
015-0339-00	Dip Clip, Low Profile (40 Pin)

P6401 Logic Probe

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

SPECIFICATIONS

Low State Input Voltage Range—0 V to +0.7 V ±0.125 V.
High State Input Voltage Range—2.175 V ±0.125 V to Vcc.
Minimum Recognizable Pulse Width—10 ns.
Impedance— ≈ 7.5 kΩ paralleled by ≈ 6 pF.
Minimum Circuit Resistance for Open Circuit Indication—10 kΩ.
Max Safe Input— ±150 V (dc or rms).
Minimum Recognizable Strobe Pulse Width—20 ns.
Max Safe Strobe Input— ±30 V (dc or rms).
Strobe Input Impedance— 5.6 kΩ within 20%.

ORDERING INFORMATION

P6401 5 ft. Probe (010-6401-01) $120

Includes: Hook Tip (206-0114-00)
Strobe Lead (175-0958-01)
Strobe Lead (175-0958-00)
Probe Tip to 0.025 in square pin adapter (206-0137-01)
White Plug (348-0023-00)
2 Alligator Clips (344-0046-00)
Accessory Pouch (016-0537-00)

P6406 and P6451 Probes

P6406 Replacement Word Recognizer Probe — For SONY®/TEKTRONIX® 308 **only.**
(010-6406-01) **$440.00**

P6451 Replacement Active Probe—
(010-6451-03) For WR 501, 7 D01, 7D01F, 7D01F2. Two probes are needed for 16 channel operation..**$470.00**
(010-6451-05) For SONY®/TEKTRONIX® 308 **only,** with right-angle connector **$470.00**

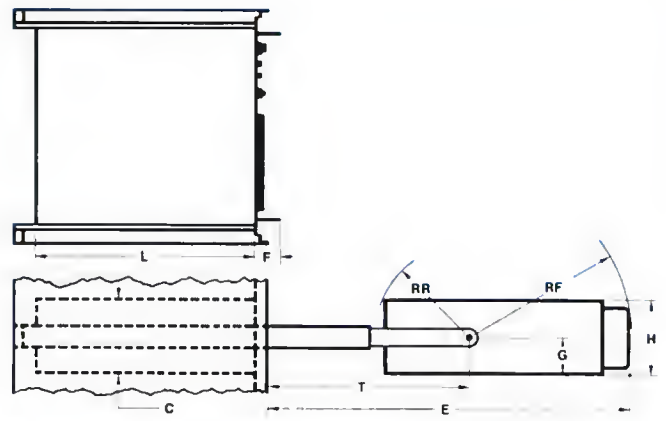
Digital Probe Accessories—See page 44.

Mounting Accessories

MOUNTING DIMENSIONS

PRODUCT	H		L		F		G		E		RF		RR		T		C	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
R434	5.3	13.5	18.0	45.7	1.6	4.0	—	—	—	—	—	—	—	—	—	—	5.3	13.5
R465B*, R475*, R-475A*	7.0	17.8	16.3	41.4	1.8	4.6	3.5	8.9	20.4	51.8	11.0	27.9	7.9	20.1	9.6	24.4	6.8	17.3
R485*	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	49.0	10.9	27.7	7.9	20.1	9.3	23.6	6.8	17.3
R491*	7.0	17.8	17.4	44.2	2.1	5.1	3.5	8.9	21.1	53.6	11.9	30.2	8.5	21.6	9.3	23.6	6.8	17.3
R5100N, R5400*	5.3	13.5	19.0	48.3	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
R7704*	7.0	17.8	22.4	56.9	2.3	5.8	1.8	4.6	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313*, R7603*, R7613*, R7623*	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	5.3	13.5
R7844*	7.0	17.8	24.8	56.6	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
R7903*	5.3	13.5	22.5	57.2	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	17.8
R7912*	5.3	13.5	26.9	68.3	1.8	4.6	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	—	—	30.7	78.0	—	—	—	—	—	—	6.9	17.5
RTM506	5.25	13.3	18.9	48.0	1.82	4.7	—	—	—	—	—	—	—	—	—	—	5.25	13.3
T922R	5.2	13.2	17.0	43.2	1.7	4.3	—	—	24.2	61.5	—	—	—	—	—	—	5.2	13.2
016-0115-02	5.3	13.5	16.3	41.4	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
016-0268-00	5.3	13.5	19.8	50.3	1.8	4.6	—	—	—	—	—	—	—	—	—	—	5.2	13.2
040-0551-01	14.0	35.6	22.4	56.9	0.6	1.5	—	—	30.9	78.5	—	—	—	—	—	—	—	—
040-0554-01	15.8	40.1	21.5	54.6	1.9	4.8	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
040-0601-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.25	13.3
040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
040-0624-01	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0126-01	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	6.6	16.8

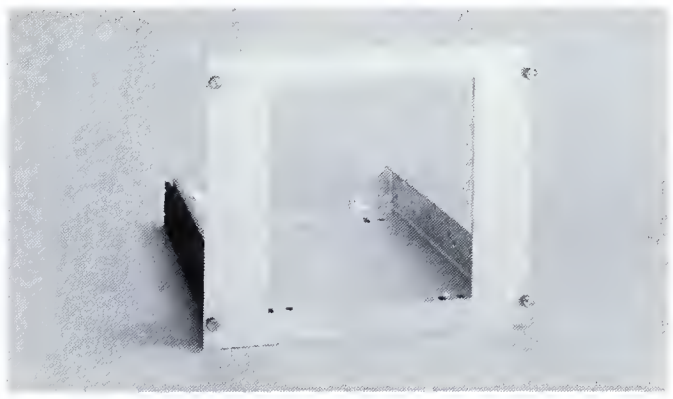
**These instruments mount with sliding tracks to a standard 19-inch-wide rack. Rear support for sliding tracks is required, such as an enclosed rack.*



DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

Symbol	Definition
H	Height of front panel.
L	Rack front to rearmost permanent fixture excluding cables.
F	Back of front panel to foremost protrusion.
G	Bottom of front panel to horizontal plane of rotation.
E	Maximum forward clearance with instrument out and horizontal.
RF	Front radius of rotation.
RR	Rear radius of rotation.
T	Rack front to pivot point.
C	Cabinet height.

RACK ADAPTERS



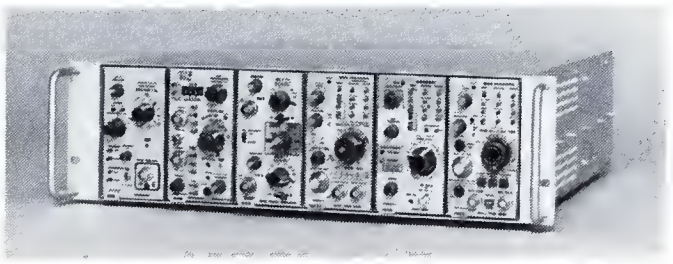
For rackmounting the 7000 Series Oscilloscopes and 611 in a standard 19 in wide rack. Rack adapter includes slide-out assemblies. 7000 Series mask finish is light gray, 611 mask finish is black.

For 7704 and 7904, rack height is 15.75 in, rack depth is 21.75 in, shipping weight is approx 41 lb.
Order 040-0554-01 .....**$705.00**

For 611, rack height is 14 in, rack depth is 21.75 in, shipping weight is approx 41 lb.
Order 040-0551-01 .....**$270.00**

For 455 and 465M, includes cradle mount, rack height 7 in, rack depth 18.75 in.
Order 040-0825-00 .....**$250.00**

STORAGE CABINETS



For 7000 Series Plug-in Units—Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high.
Order 437-0126-03 .....**$340.00**

For 1-Series and Letter-Series Plug-in Units—Holds 3 plug-in units. Measures 19 in wide, 8¾ in high, 9⅜ in deep. Net weight is approx 9 lb.
Order 437-0031-00 .....**$95.00**

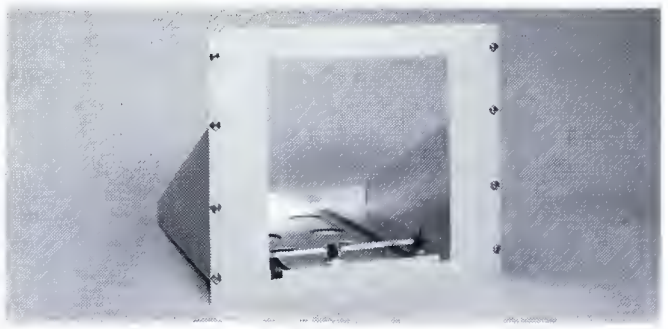
For 2 and 3-Series Plug-in Units—Holds 4 plug-in units. Measures 19 in wide, 7 in high, 13-5/16 in deep. Net weight is approx 10 lb.
Order 437-0071-00 .....**$115.00**

REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19 in backless rack. Shipping weight is approx 3 lb.
For R561B, R564B, and R647A.
Order 040-0344-00 .....**$25.00**

For RM565 and R567.
Order 040-0346-00 .....**$35.00**

CRADLE MOUNTS



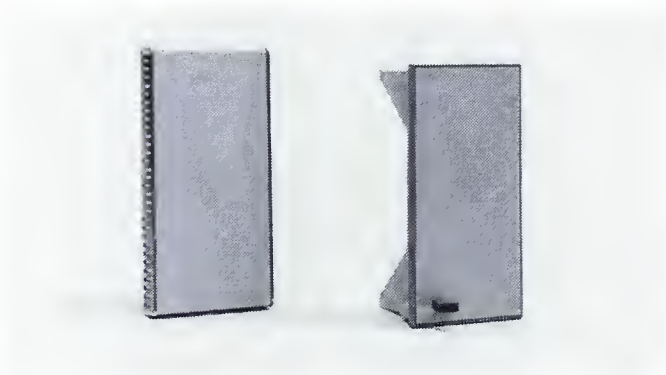
For rackmounting 500 and 7000 Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500 Series mask finish is blue vinyl, and 7000 Series mask finish is light gray.

For 7704A, rack height is 15.75 in, rack depth is 22 in, shipping weight is approx 16 lb.
Order 040-0560-00 .....**$370.00**

For 540 Series and 575, rack height is 17.5 in, rack depth is 21-9/16 in, shipping weight is approx 16 lb.
Order 040-0281-00 .....**$215.00**

For 561B and 564B, rack height is 15.75 in, rack depth is 21-9/16 in, shipping weight is approx 17 lbs.
Order 040-0321-01 .....**$200.00**

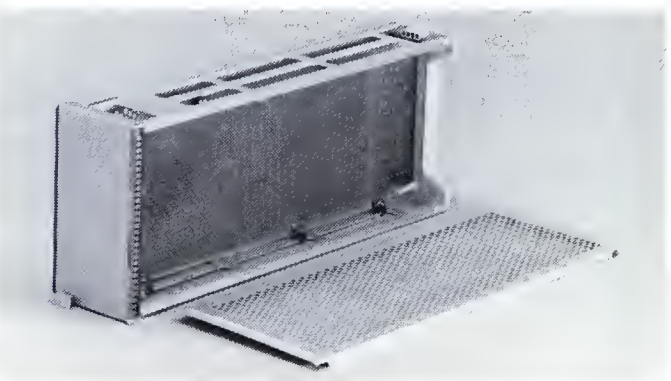
BLANK PANEL



Blank Panel—When operating the 5000/7000 Series Mainframes or the TM 500 or 2600 Series Generators with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

7000 Series, 2600 Series, Order 016-0155-00...$35.00
5000 Series, Order 016-0452-00 .....**$15.00**
TM 500 Series, Order 016-0195-03 .....**$21.00**

BLANK PLUG-IN CHASSIS

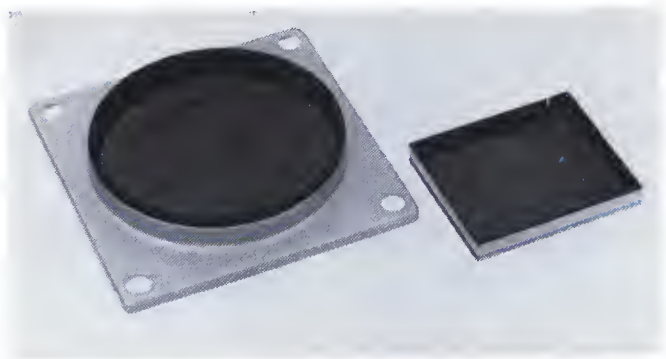


Blank Plug-in Chassis—Available for all Tektronix Mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

7000 Series, Order 040-0553-01 .....$155.00
5000 Series, Order 040-0818-03 .....$ 75.00
TM 500 Series, Order 040-0652-05 .....$ 75.00
560 Series, Order 040-0245-00 .....$110.00
1 and Letter Series, Order 040-0065-00 .....$80.00

Viewing Accessories

CRT MESH FILTERS



The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions. The filter is a direct replacement for the existing graticule cover on most Tektronix instruments, or, In the case of the new portable oscilloscopes, snaps in the CRT opening on the front panel.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

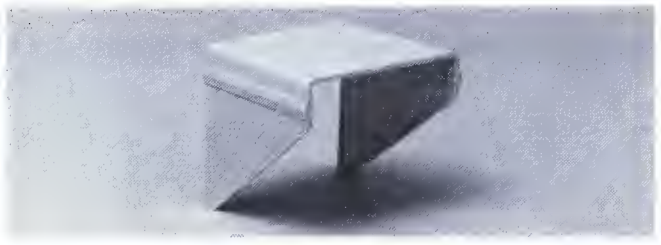
The mesh filter also serves as an emc filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the emc spectrum.

INSTRUMENT*	PART NUMBER	PRICE
314, 326, 335	378-0063-00	$27.00
323, 324	378-0596-00	25.00
432, 434	378-0682-00	33.00
422, 491, 453A, 454A, 485	378-0648-00	20.00
465,465B,475,464,466,434	378-0726-01	33.00
540 Series, 565	378-0572-00	36.00
529, 561B, 564B, 568	378-0575-00	35.00
7400, 7603	378-0696-00	30.00
7500, 7700, 7800, 7900 Series and 7613, 7623, 7633	378-0603-00	30.00

**For both cabinet and rackmount instruments.*

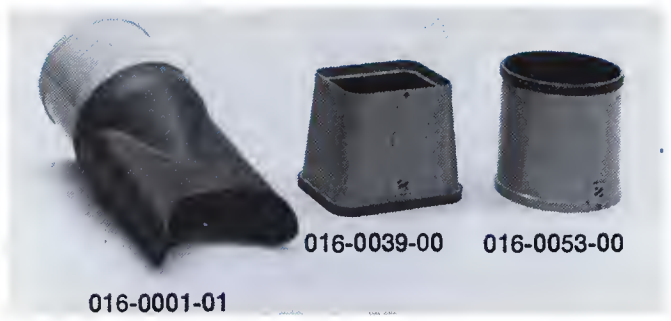
VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezel-viewer compatibility before ordering.



View Hood (folding)—for 200 Series, 314, 323, 324, 326, 335, 400 Series, 576, 577, 5000, and 7000 Series Oscilloscopes.

For 576, order 016-0259-00 ..... $16.00
For 577, 5000, and 7000 Series order 016-0260-00 ..... $10.00
For 200 Series (not pictured), order 016-0199-01 ..... $ 6.50
For 323 and 324 (not pictured), order 016-0247-01 ..... $ 7.25
For 326, 314, 335, SC 502, SC 504 (not pictured), order 016-0297-00 ..... $ 6.50
For 464, 466, 455 (not pictured), order 016-0592-00 ..... $12.00



Polarized Viewers—For Tektronix 5 inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

Rectangular Viewer, order 016-0039-00 ..... $60.00
Plastic Round Viewer, order 016-0053-00 ..... $34.00

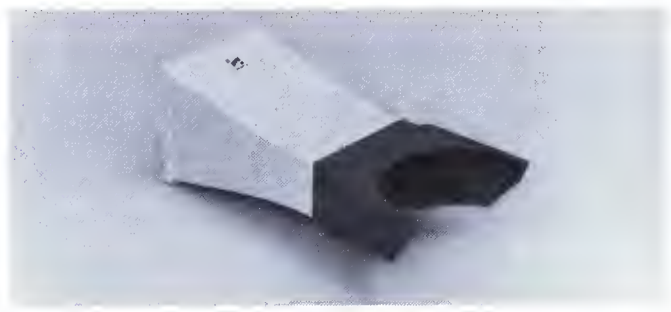
Viewing Hood—For Tektronix 5 inch oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.

Order 016-0001-01 ..... $35.00

Collapsible Viewing Hood—For oscilloscopes with rectangular CRTs. Blue vinyl material, folds flat for convenient storage.

For 422, 453A, 454A, 485, 491, order 016-0082-00 ..... $15.00
For 422, 453A, 454A, 485, 491, order 016-0274-00 ..... $15.00

Polarized Collapsible Viewing Hood—To reduce reflections and glare under high ambient light conditions for 432, 434, 455, 465, 465B, 475, 464, 466, order 016-0180-00 ..... $27.00



Viewing Hood—For 576, 5000 and 7000 Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

For 576, order 016-0153-00 ..... $20.00
For 5000 and 700 Series, 601, 602, 603, 604, 528 and 577, order 016-0154-00 ..... $20.00

Viewing Hood (folding binocular) — For some 400 Series.

For 434, 455, 464, 466, 465B, 475 and 475A.
Order 016-0566-00 ..... $15.00

CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
314, 335	Blue	378-2016-01	$1.80
	Amber	378-0843-01	1.80
200 Series	Blue	378-0691-00	1.00
455	Clear	337-2122-01	2.50
	Blue	337-2122-00	3.05
323, 324	Smoke-gray	426-0403-00	3.10
	Blue†	426-0811-00	3.10
	Amber	426-0513-00	3 10
326	Blue†	426-0871-00	3.10
422, 491, 453A, 454A, 485	Smoke-gray	378-0549-00	1.50
	Green	378-0557-00	1.50
	Blue†	378-0664-00	1.50
	Amber	378-0559-00	1.50
465, 465B, 475, 464, 466	Blue	337-1674-00	4.00
	Clear	337-1674-01	4.00
	Smoke-gray filter	337-1674-07	4.00
540, 550 Series, 565, 575	Smoke-gray†	378-0567-00	3.50
	Green	378-0568-00	3.00
	Blue	378-0569-00	3.00
	Amber	378-0570-00	3.50
529, 561B, 567, 568	Smoke-gray†	378-0560-00	3.00
	Green	378-0561-00	3.00
	Blue	378-0562-00	3.00
	Amber	378-0563-00	5.00
520A, 521A, 522A	Smoke-gray†	378-0581-00	3.15
576	Blue†	378-0616-00	2.75
	Amber	378-0616-01	2.75
602	Blue	378-0845-00	4.00
	Smoke-gray†	378-0586-00	4.00
	Amber	378-0595-00	10.00
	Graticule	331-0406-00	7.00
603, 604	Clear (603†)	337-1440-00	2.50
	Green	337-1440-01	2.50
	Amber	337-1440-02	3.50
	Blue	337-1440-03	3.50
	Gray	337-1440-04	3.50
	Graticule (8x10 div)	331-0303-00	4.00
605, 606, 607	Blue	337-1674-00	4.00
	Amber	337-1674-05	4.00
	Graticule	337-1674-10	4.00
	Clear Shield	337-1674-13	4.00
	Gray†	337-1674-06	4.00
	Graticule (8x10 div)	331-0391-00	4.00
608	Amber	378-0704-00	4.00
	Green	378-0705-00	4.00
	Graticule†	337-2126-02	7.00
7904, 7844, 7313, 7700 Series, 7613 7623	Blue†	378-0625-00	2.50
	Amber	378-0625-01	2.20
	Gray	378-0625-02	2.50
	Green	378-0625-03	2.50
	Gray Tv Graticule CCIR	378-0625-05	5.00
	Gray Tv Graticule NTSC	378-0625-06	5.00
	Clear Shield With Spectrum Analyzer Graticule	337-1159-02	5.00
7613, 7623, 7623A, 7633	Spectrum Analyzer	378-0625-07	5.00
	Green (UV) Tv Graticule	378-0625-08	2.50
	CCIR Tv Graticule	378-0625-09	5.00
	NTSC	378-0625-10	5.00
7403N, 7603	Blue	378-0684-00	4.20
	Amber	378-0684-01	4.20
	Gray	378-0684-02	4.20
	Green	378-0684-03	4.20
	Gray Tv Graticule CCIR	378-0684-04	7.00
	Gray Tv Graticule NTSC	378-0684-05	7.00
	With Spectrum Analyzer Graticule	337-1439-01	5.00
	Blue Implosion Shield†	337-1700-01	5.00
	Clear Implosion Shield	337-1700-04	5.00
5100 and 5400 Series (except 5441)	Clear	337-1440-00	2.50
	Green	337-1440-01	2.50
	Amber	337-1440-02	3.50
	Blue	337-1440-03	3.50
	Gray	337-1440-04	3.50
5441	Clear†	337-1674-01	4.00
	Gray	337-1674-06	4.00
	Graticule (8x10 div)	331-0391-00	4.00
434	Blue	378-0678-01	1.50

**For both cabinet and rackmount instruments unless rackmount version is listed.*

†Standard filter supplied with instrument.

Accessory Covers

OSCILLOSCOPE PROTECTIVE COVERS

The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000 Series Laboratory Oscilloscopes have clear vinyl frontal areas.

PROTECTIVE COVERS

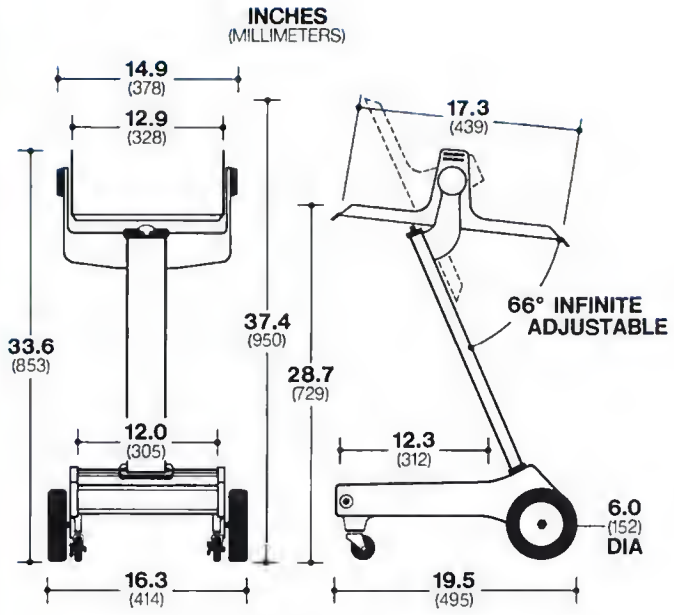
INSTRUMENT	PART NUMBER	PRICE
200 Series	016-0512-00	$15.00
323, 324, 1401A, 1401A-1, 1501	016-0112-00	17.00
314, 335	016-0612-00	65.00
326	016-0532-00	55.00
453A, 454A, 491	016-0074-01	18.00
455	016-0344-00	18.00
434, 464, 466	016-0365-00	21.00
465, 465B, 475, 485	016-0554-00	17.00
560 Series (except 565, 567, 568)	016-0067-00	17.00
565, 567, 568	016-0069-00	17.00
540 Series	016-0068-00	17.00
1480C, 1481C, 1482C, 1485C	016-0085-00	16.00
5000 Series	016-0544-00	25.00
7300, 7400, 7600 Series	016-0192-01	17.00
7704A, 7900	016-0531-00	15.00

PLUG-IN UNIT CARRYING CASES

CARRYING CASE FOR 2, 3, 10, AND 11 SERIES PLUG-IN UNITS—Accommodates two plug-in units.
Order 437-0070-00 .....$85.00

CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 .....$55.00

SCOPE-MOBILE® Carts



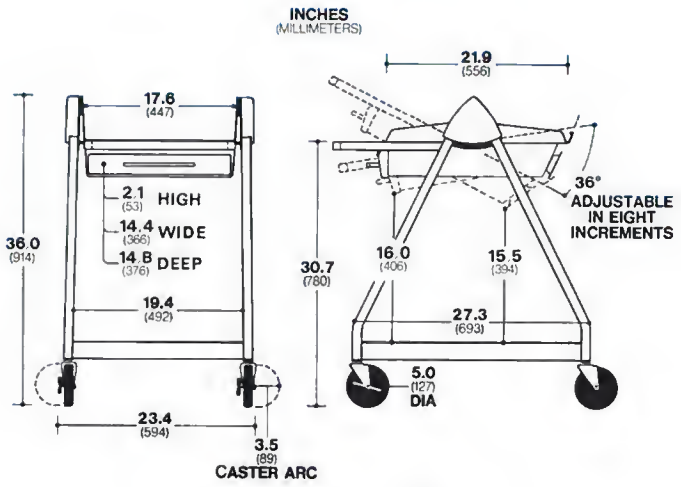
MODEL 200C

Recommended For:

All 400 Series Portable Scopes.

MODEL 200C includes brakes on front casters, safety belt to secure instrument on top tray. Blue vinyl finish. Net weight 16 lb, 7.3 kg. Shipping weight 27 lb, 12.2 kg.

Order Model 200C $235



MODEL 205

Recommended For:

All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray.

MODEL 205 includes brakes on front casters, storage drawer, power distribution module (three outlets, 15 ft cord). Blue vinyl finish. Net weight 43 lb, 19.5 kg. Shipping weight 57 lb, 25.8 kg.

Order Model 205 .....$360

OPTIONAL SAFETY BELT recommended to secure instruments on top tray. Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

Order 346-0070-01 .....$42

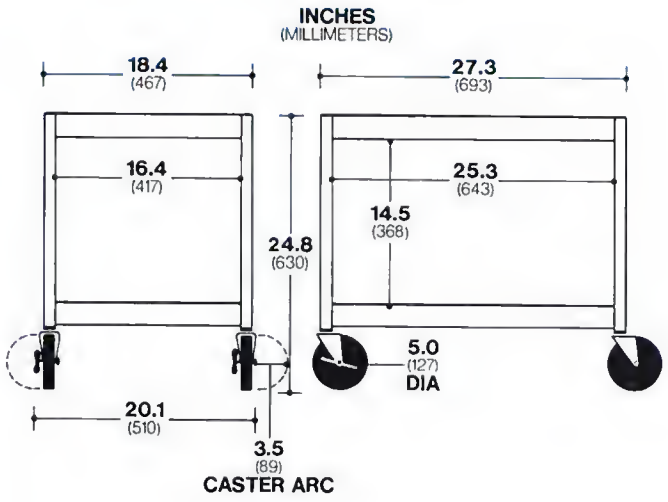
Carts

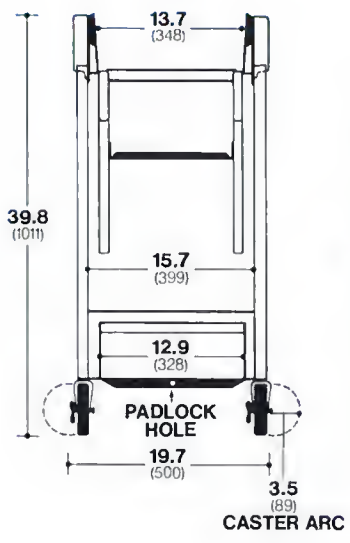
QUICK REFERENCE

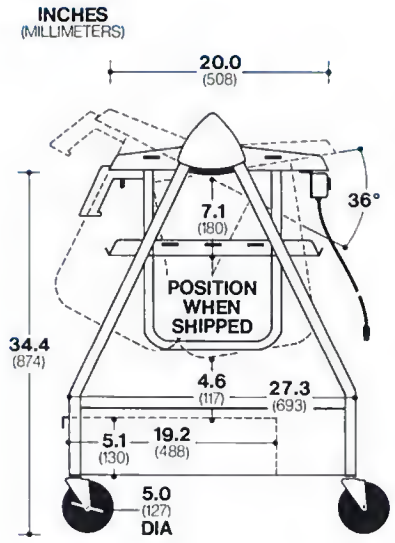
Product	Cart Model
TM 503	3
TM 504	3
TM 506	205
21	206
31	206
432	200C
434	200C
455, 465M	200C
464	200C
465B	200C
466	200C
475, 475A	200C
485	200C
491	200C
520-522	205
528	*
530, 540, 550 Series	3
560-Series	3
576	206
577	206
602-607	*
611	205
613	205
632	205
650 Series	205
670 Series	205
1105	*
1140A	205
1340	205
1420 Series	*
4601	206
4610	206
4623	206
4632	206
4661	206
4921	206
4922	206
5100 Series	3
5400 Series	3
7104	3
7313	3
7603	3
7613	3
7623A	3
7633	3
7704A	3
7834	3
7844	3
7904	3

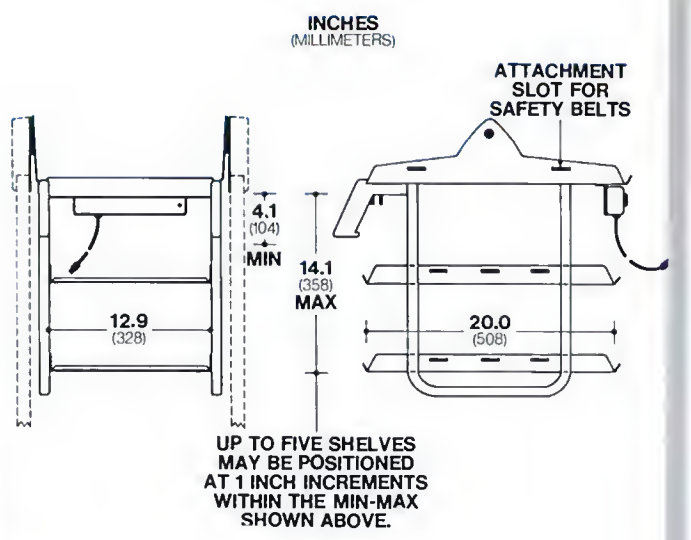
*These products are applicable to several carts—see dimensions and features for your specific needs.

Lab Carts









MODEL 206

Recommended For:

Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment.

MODEL 206 includes brakes on caster at one end of cart. Plastic laminate on top tray and base. Light gray vinyl finish. Net weight 30 lb, 13.6 kg. Shipping weight 38 lb, 17.2 kg.

Order Model 206 . . . . . **$165**

TEK LAB CART MODEL 3

Recommended For:

Max Recommended weight 65 lbs on tray top.

5100, 5400, and 7000 Series three and four plug-in oscilloscopes, all 400 Series, TM 503, and TM 504 mounted on top tray.

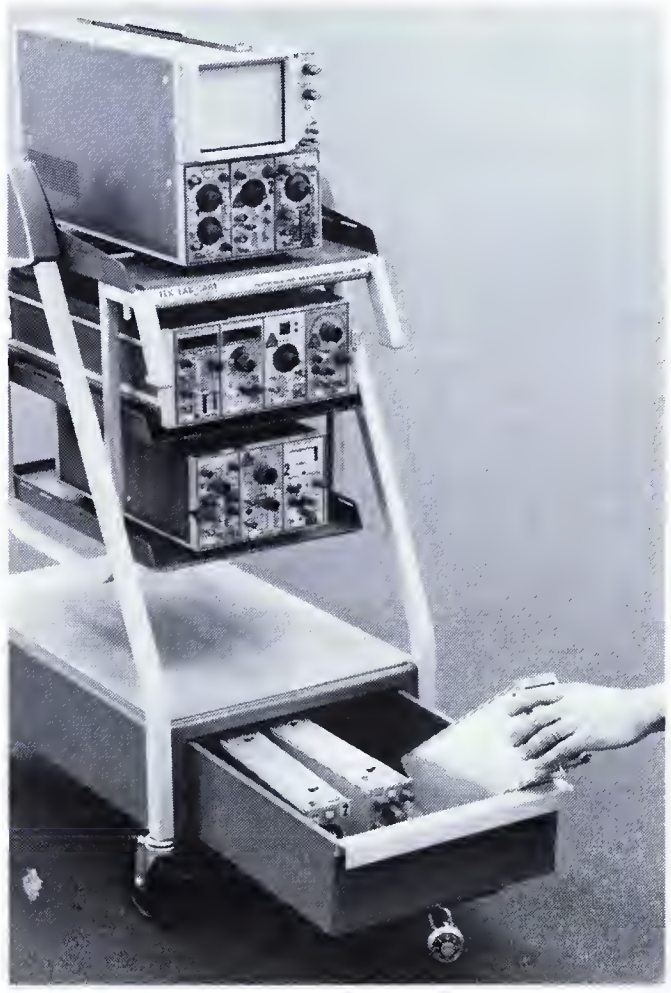
TM 503, TM 504 mounted on shelves.

MODEL 3 includes drawer in base with provision for padlock, brakes on all casters, power distribution module (four outlets and 15 ft cord), removable scope lock-down bar on top tray, one shelf, one safety belt, UL Listed. Net weight 57 lb, 25.8 kg. Shipping weight 75 lb, 34 kg. Blue vinyl finish.

Order Model 3 . . . . . **$425**

INTERNATIONAL VERSION deletes power module for shipment outside U.S.A.

Order Option 01 . . . . . **No Charge**



Optional Accessories

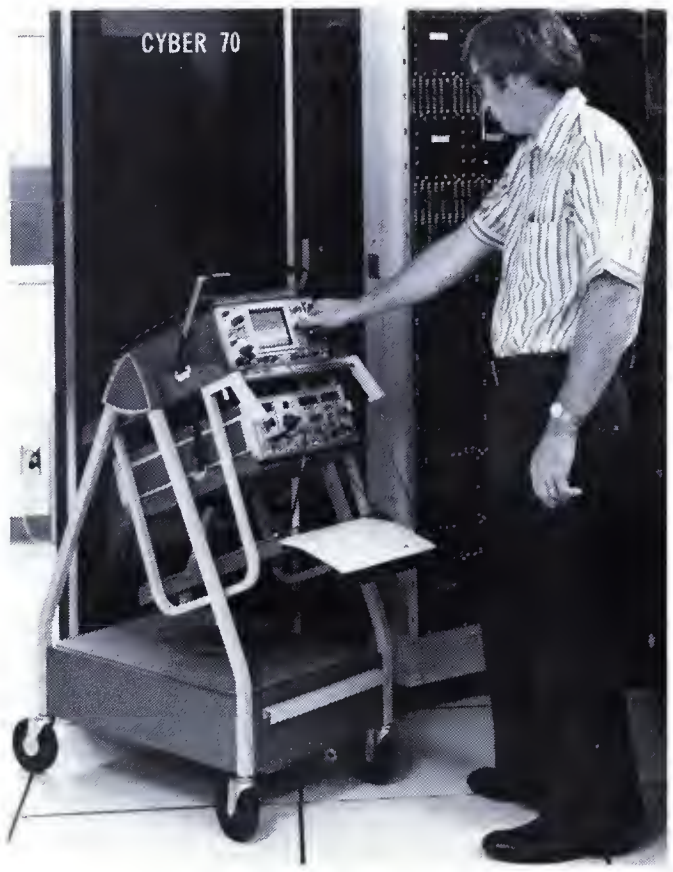
Extra shelf with four mounting screws. Net weight 0.9 lb, 0.4 kg. Shipping weight 3 lb, 1.4 kg.

Order 436-0132-01 . . . . . **$32.00**

SAFETY BELT to secure instruments on top tray, shelves, or base. (Not needed for 5000 or 7000 Series Scopes on top tray.) Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

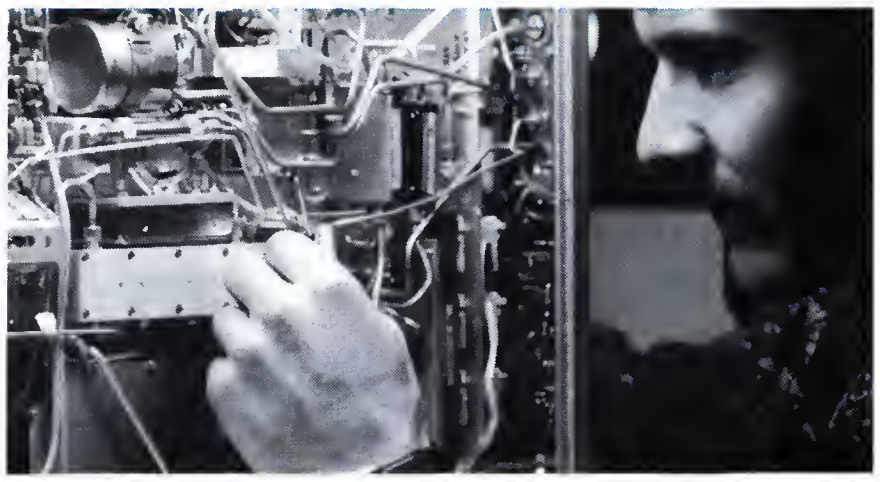
Order 346-0136-01 . . . . . **$21.00**

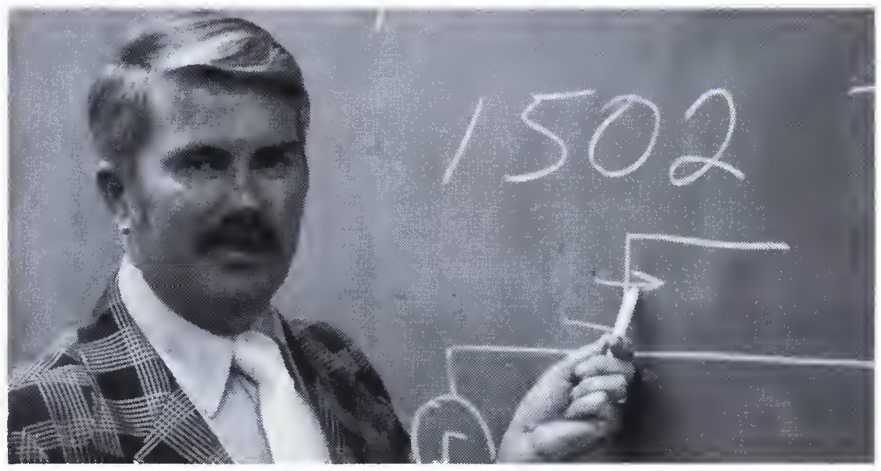
For 7000 or 5000 Plug-in Storage on shelves contact modified products.

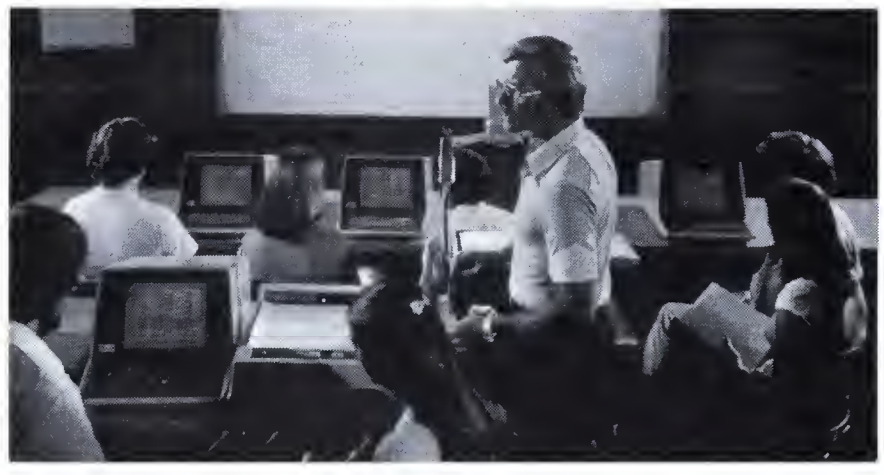


The Model 3 is shown with the 436-0132-01 Optional Shelf.

Customer Information







Ordering Information
Factory Training
Applications
Calibration & Certification
Customer Assistance
Product Services
Emergency Repair
Maintenance Agreements
Repair Parts
Customer Training
Terms of Sale

When you buy a Tektronix product, you are buying more than an oscilloscope . . . or a computer terminal . . . or a logic analyzer . . . or any of our numerous test and measurement products. You are also investing in the many people and services behind your Tektronix product.

A staff of Customer Service Representatives serves as your initial interface with the company.

Trained Sales Engineers give you expert service advice and after-the-sale support.

A network of service centers throughout the U.S. and most other parts of the world provides speedy and competent calibration, maintenance, and repair service.

The long term support program insures years of service after a product is removed from the production line.

The training and support program offers classes in Tektronix product theory, operation, maintenance, and repair at our main plant in Beaverton, Oregon and at various locations throughout the world. Audio and video training tapes are also available.

Each of these services adds value to your Tektronix product.

SALES ENGINEERS

Your Sales Engineers are fully prepared to respond to your technical and business requirements. They have a strong technical background and extensive product and business training. Periodic refresher courses fully acquaint them with new products and services. Be sure to take advantage of their services.

COMMUNICATIONS

Your Sales Engineers are a valuable communication link between you and the factory. They know the exact person to contact in each circumstance, and can reach that person fast and easily. Let them help your communications on any problem related to your Tektronix products.

ORDERING

There are many types of products, each designed for a specific application area. Your Sales Engineer can help you select the one best suited to your present and future needs, and will be happy to arrange a demonstration of the product . . . in your application if you so desire.

If you are a Purchasing Agent or Buyer, your Sales Engineer or Customer Service Representative can provide information on prices, terms, shipping estimates, and best method of transportation on Tektronix products, accessories and replacement parts.

Tektronix Service and Support

OPERATION

Your Tektronix product can be most useful to you when you are familiar with all control functions. Your Sales Engineer will be glad to demonstrate the use of your product in various applications to help you become more familiar with its operation. If your product is to be used by several engineers or other users, your Sales Engineer will be happy to conduct informal classes on its operation in your location.

FACTORY TRAINING

Often there is a need for in-depth training that cannot be fully accomplished locally. To meet these needs, Tektronix has established a program of factory training which is an extension of Tektronix Sales Engineering. Customers who participate in this program attend classes at the Tektronix customer training centers located in the Tektronix Industrial Park in Beaverton, Oregon, or the European Marketing Centre in Amstelveen, The Netherlands. Your Sales Engineer has full details, and will make all the arrangements.

APPLICATIONS

To assist you with in-depth knowledge of specific areas, your Sales Engineers are backed up by specialists in such fields as: Signal Processing Systems, Television Products, Information Display Products, Spectrum Analyzers, Logic Analyzers, and Microcomputer Development Products. At your request, they will arrange to demonstrate Tektronix instruments for you — in your application, if you wish.

TRACEABILITY

The reference standards of measurement of Tektronix are compared with the U.S. National Standards through frequent tests by the U.S. National Bureau of Standards.

The Tektronix working standards and testing apparatus used are calibrated against the reference standards in a rigorously maintained program of measurement control.

The manufacture and final calibration of TEKTRONIX products are controlled by the use of Tektronix reference and working standards and testing apparatus in accordance with established procedures and with documented results. (Reference MIL-C-45662A)

Certificates of traceability to NBS are available with new products, as well as products you may have serviced at a later date.

A certificate of compliance stating that a particular product being shipped conforms to its published (or quoted) specification is also available.

CALIBRATION & CERTIFICATION

Services furnished are provided in accordance with all applicable Tektronix specifications. Actual test data can be made available when required.

Tektronix' calibration measurements are traceable to the National Bureau of Standards to the extent allowed by the Bureau's calibration facilities.

TEKTRONIX Service Quality Program satisfies the requirements of MIL-I-45208A, and MIL-C-45662A.

CUSTOMER ASSISTANCE

Tektronix willingly assumes much of the responsibility for continued efficient operation of the products it manufactures. If you should experience a stubborn maintenance problem, we will gladly help you isolate the cause. Often a telephone call will help you get your product back in operation with minimum delay. If yours is a large laboratory, we can help your maintenance engineers by conducting informal classes on test and calibration procedures, troubleshooting techniques, and general maintenance.

PRODUCT SERVICE

To help assure adequate product service and maintenance facilities for our customers, Tektronix has established Field Offices and Service Centers at strategic points throughout the United States. Contact your Sales Engineer or Service Center for details concerning • Warranty • Calibration • Emergency Repairs • Repair Parts • Scheduled Maintenance • Reconditioning and Overhaul • Pickup and Delivery • Maintenance Agreements • On-Site Service for Fixed Installations — Other Services available through these local offices and centers. Outside the United States, service is offered in all countries where the products are locally sold.

EMERGENCY REPAIR

Should an emergency arise — at home or on the road — just bring your instrument to the Service Center nearest you. We'll try our best to repair it while you wait. In most cases, we'll get you on your way in a matter of minutes.

MAINTENANCE AGREEMENTS

Your TEKTRONIX products are initially covered by warranty. Several types of contracts are usually available to help you extend that initial coverage. The Blanket Repair Agreement, for example, allows you to establish a "not-to-exceed" amount, it also saves on paperwork by centralizing the billing procedure. Many other aspects of service are negotiable.

If you'd like us to maintain your products on a regular basis, ask a service center about our fixed fee maintenance program, which is available in most countries. For a fixed cost that you can budget for, we'll remind you when a product is due for calibration, and perform the service within a specified turnaround time.

Contact your service center for a schedule of service fees, more information about maintenance agreements, local services offered, or possible provisions for your special requirements.

REPAIR PARTS

Repair and replacement parts service is geared directly to the field, therefore, all requests for repairs and replacement should be directed to the Tektronix Field Office in your area. This procedure will assure you the fastest possible service. Please include product type number and serial number with all requests for parts or service. PLEASE DO NOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

TEKSCOPE

A bimonthly publication whose objective is to provide informative, timely articles presented in a readable manner across the whole of Tektronix technology. Each issue of TEKSCOPE contains articles describing instruments, measurements, and techniques. The New Products section provides information on products recently introduced, including photos, brief descriptions of unique features, and major specifications for each product.

CUSTOMER TRAINING

Tektronix has established several types of training programs for the users of Tektronix products.

Microprocessor Workshops and Maintenance Training Classes are offered at the Tektronix Industrial Park, just outside of Portland, Oregon, and at a number of field locations across the country. Software classes and training on Semiconductor Test Systems are held at the Industrial Park.

You may purchase audio tapes on instrument operation, circuit and block descriptions, and calibration, and video tapes which cover basic concepts as well as instrument operation and applications to enhance your own training programs.

For independent study, review, and reference, Tektronix Training Packages combine audio or video tapes with printed materials to offer a new, multi-media approach to your training needs.

Additional information on all of these training programs is available from your nearest Tektronix Field Office. You may also request a copy of the Tektronix Customer Training Catalog on the return card at the back of this catalog.

Special Information for OEMs

At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation — we offer these and other products on a special basis to the original equipment manufacturer.

But terms and conditions tell only part of the Tektronix OEM story. Our products have the quality, reliability, and the top performance per dollar that the OEM needs to stay competitive.

Our Product Reliability Is Your Foundation

Any system is only as reliable as the components that go into it. At Tektronix, we're committed to producing the most dependable system components possible. You can be confident that the reliability we design into our equipment can help keep your customers satisfied. That's reliability you can build on.

Choose The Performance Level To Match Your System

In many product areas our wide range of OEM components allows you to select just the optimal performance you need for the system you are building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you pay for exactly the performance level you need—no more, no less.

Special OEM Terms and Pricing Help Keep You Competitive

Within the range of OEM components, we offer a variety of different OEM pricing arrangements and terms. Ask your local Tektronix representative about the special OEM terms and pricing available to you.

Service and Support— When and Where You Need It

Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

You and Tektronix: A Quality Partnership

Explore the advantages of working with Tektronix: excellence in products, in support, and in service.

Your local Tektronix representative can help you get full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.

CORPORATE WARRANTY

Tektronix warrants that the products that it manufactures and sells or leases are free from defects in materials and workmanship. If any product that is manufactured and sold or leased by Tektronix fails to operate properly during the applicable warranty period as a result of a defect in materials or workmanship, Tektronix, at its option, either will repair the defective product and restore it to its normal operation without charge for parts and labor or will provide a replacement in exchange for the defective product.

In order to obtain service under the terms of the warranty, the customer must notify Tektronix of any defects before the expiration of the warranty period and make suitable arrangements for the performance of service.

Tektronix will provide on-site service under the terms of its warranty without additional charge on products installed by Tektronix and certain other designated products if the service is performed within the normal on-site service area. Tektronix will provide on-site service outside this area only upon prior agreement and upon payment of all travel expenses by the customer. In all other cases, the customer shall be responsible for packaging and shipping the products to the designated Tektronix Service Center, with shipping charges prepaid. Tektronix shall pay for the return of any products to the customer if the shipment is to a location within the country in which the Service Center is located. The customer shall be responsible for paying all shipping charges, duties, taxes, etc., for products returned to any other locations.

The applicable warranty periods and the warranty service provided for different categories of products are shown in the table below:

PRODUCT CATEGORIES	WARRANTY SERVICE PROVIDED
Test and Measurement Type Products: Oscilloscopes and Plug-Ins; Modular Test and Measurement Instruments; Data Communications Analyzers; Logic Analyzers; Spectrum Analyzers; Television Products (except ANSWER System).	Parts and labor at Service Center for 1 year from date of shipment.
Cameras, Carts, and Probes	Parts and labor at Service Center for 1 year from date of shipment.
Cathode Ray Tubes	Parts and labor at Service Center for 1 year from date of shipment.
Computer Graphics Products; Microcomputer Development Products; ANSWER System	Parts exchanged at Service Center for 1 year from date of shipment.
Signal Processing Systems; Semiconductor Test Systems; 4081 Graphics System	Parts and labor on-site for 90 days from date of installation or 120 days from date of shipment, whichever is shorter.

The foregoing warranty shall not apply to any damage or defects caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under the warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or from connecting the product to incompatible equipment; or c) to service a product that has been modified or integrated with other products not covered by a Tektronix warranty when the result increases the time or difficulty of servicing the product or increases the likelihood of damage to the product.

For information on the warranty period for any specific product and for further details regarding Tektronix warranties and service policies, please consult your local sales office. A complete statement of Tektronix' warranty for specific products will be supplied at the time of sale or upon request.

The warranty statement supplied at the time of sale is the exclusive warranty and is given in lieu of any other warranty express or implied. Tektronix explicitly disclaims any implied warranties of merchantability and fitness for a particular purpose.

Tektronix' responsibility to repair or replace defective products is the sole and exclusive remedy provided to the customer for breach of any warranty. Tektronix will not be liable for any direct, indirect, special, incidental or consequential damages.

General Terms of Sale

Orders should be placed with your Tektronix Office listed on page 308.

Tektronix, Inc., offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning. Any of the following terms may be arranged with a Tektronix Sales Engineer.

NET 30 DAYS

Tektronix, Inc., standard terms of sale are NET 30 days following the date of shipment. As with all credit terms, satisfactory credit accommodations must be arranged.

EXTENDED TERMS OF SALE

Extended terms of 60 to 180 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended.

LEASE AGREEMENT

All new and used instruments are available under this program. Accessories and parts are not available unless they are associated with the products being leased. Minimum lease is $1000.

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement, the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, exercise the purchase option, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price.

The standard Tektronix, Inc., warranty and quantity discount apply to products leased under this installment term.

SECURITY AGREEMENT

This program provides monthly installment payment terms while Tektronix products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

A minimum advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from $200 for six months to $2000 for thirty-six months. Longer terms of 48 to 60 months are available by quotation for financed balances of more than $10,000. There are no maximum finance balances.

All products carry the standard Tektronix, Inc., warranty. The customer is responsible for the equipment and applicable property taxes, licenses, etc. Upon completion of the term of agreement and prescribed payments, the customer owns the equipment.

COMPUTER GRAPHIC PRODUCTS

Most Computer Graphic Products are available under an *operating lease* program. The minimum fixed terms of this program are 12, 24, 36 months, or longer. Automatic extension on a month-to-month basis is also available after the fixed minimum term. Equipment leased on this program is maintained by Tektronix, Inc., during the terms of the agreement. Rental of Computer Graphic Products for customer evaluation is available for periods of 90 or more days.

During the term of the operating leases or rentals described, the customer may exercise an option to purchase the equipment provided 30 days notice is given. A portion of the installments already paid will be credited toward the purchase price. Questions regarding warranty should be discussed with your Tektronix Sales Engineer.

SHIPMENT

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical method. Surface and air shipments will be insured at full valuation unless your order instructs otherwise.

Specification and price change privileges reserved.

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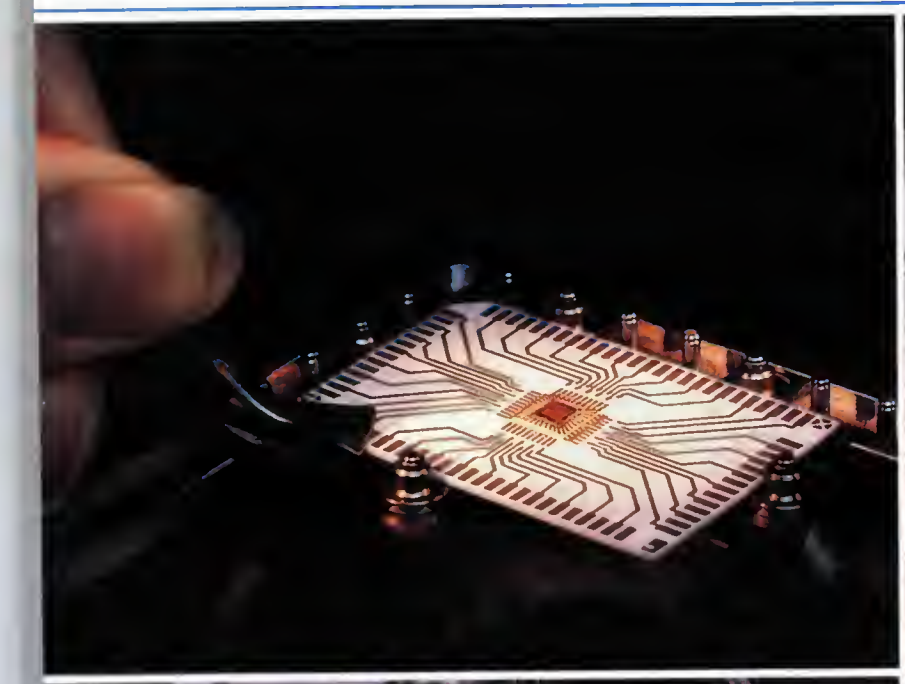

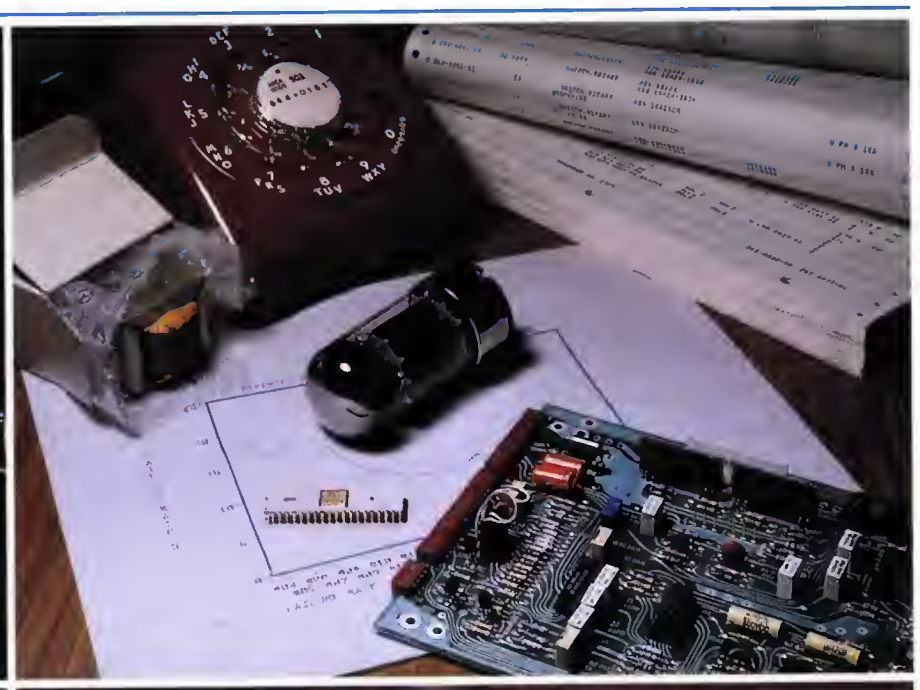

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